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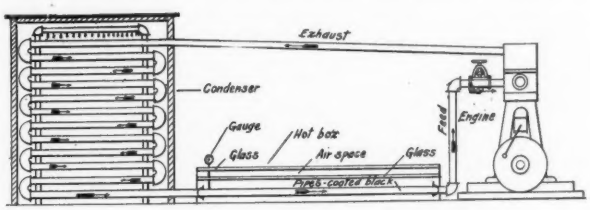
A NEW DIRECT ACTING SOLAR ENGINE

Method of Obtaining Power from the Sun

By using the principle of the common hotbed used by farmers and florists, Mr. Frank Shuman, engineer and chemist, of Tacony, Pa., thinks he has solved the old problem of converting the heat of the sun into power at such a low cost that its utilization for commercial purposes will be both practicable and economical.

This new direct-acting solar engine is based on the principle of utilizing the direct rays of the sun, without concentration, in what is termed a "hot box," which acts to conserve the rays of the sun. This "hot box," as used by him, has the appearance of a large hotbed and consists of a flat wooden box, 18 x 60 feet, sunk into the ground, in which is laid coils of iron pipe painted black. Above the



Cycle of the Solar Engine

pipes is a double top of ordinary hothouse glass with a one inch air space between the layers. The light rays of the sun (or the radiant heat) penetrate the double glass cover and are absorbed and converted into ordinary heat by the blackened surfaces of the pipes; the air space and double layer of glass preventing the heat from escaping. This heat is absorbed in the liquid contained in the pipes, and generates pressure which drives the engine. The exhaust then passes into a condenser where it is condensed to the fluid state and from the condenser it flows back to the "hot box;" thus constituting an endless cycle. In the latitude of Philadelphia temperatures of over 200 degrees Fahr. have been reached and it is thought that in tropical latitudes over 300 degrees could be attained. In the present installation, ether is used in the "hot box," but in tropical latitudes it is claimed that ordinary water can be used.

The accompanying illustration shows the direct-acting solar engine pumping water from an artesian well. The long flat box is the "hot box" containing the coils of pipe in which the ether is vaporized. The vapor passes through the pipe, shown in front of the "hot box" to the cylinder of a small vertical engine, of the donkey type, developing three and one-half horse-power. The coils of pipe constitute the condenser through which the exhaust from the engine passes. A stream of water flowing down over the pipes condenses the exhaust vapor to its liquid state and from the condenser it flows back through the pipes in the "hot box" ready to be vaporized again. A small pump of the duplex type is belted to the engine. As shown in the illustration, the engine is pumping water, with a pressure of 120 pounds in the steam cylinder.

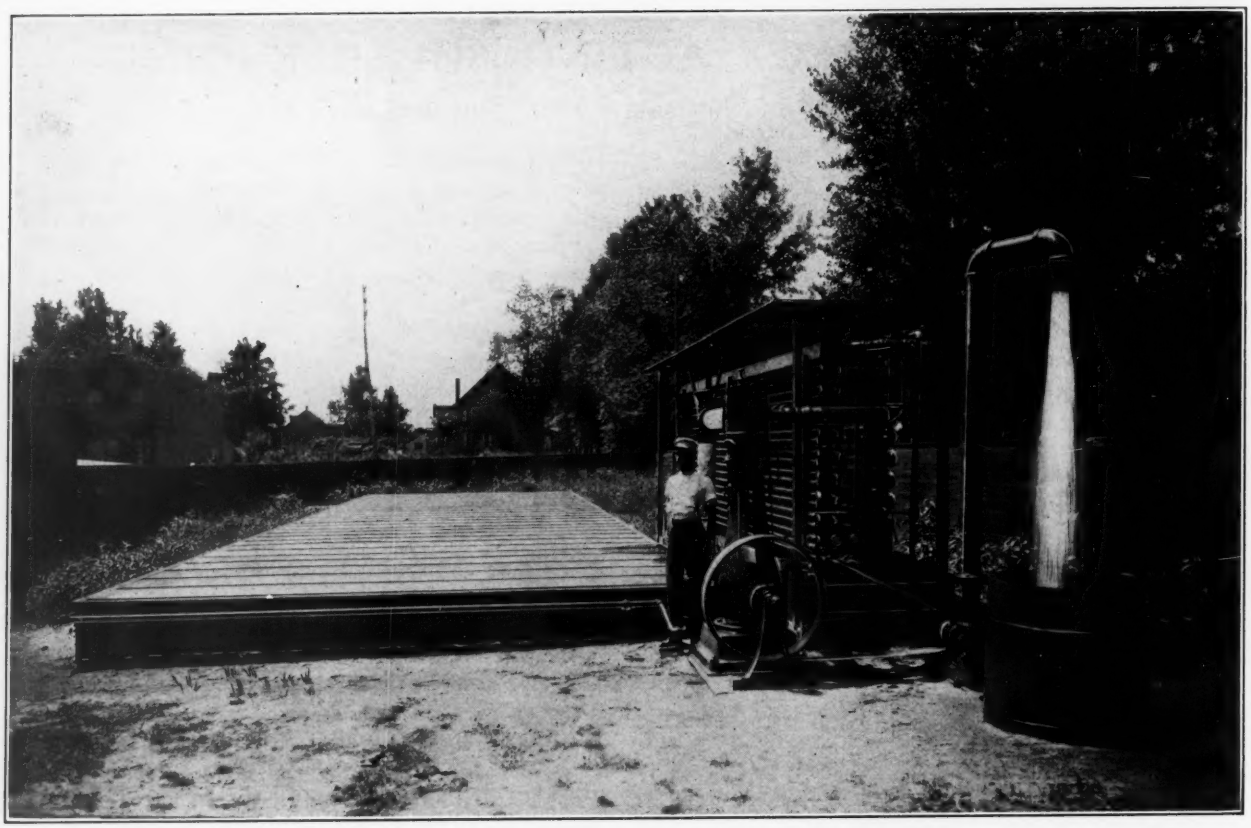
Speaking of his solar engine Mr. Shuman said, "There is nothing new about it; steam engines have been known for years and so have hotbeds; they have merely been combined here. Formerly solar engines were built on the principle of concentrating the sun's rays on a boiler, this boiler running the engine. This necessitated the construction of elaborate reflecting devices, costly and unreliable. It was also necessary to keep these reflectors constantly pointed toward the sun which required complicated clock movements. Thus it can readily be seen that with such delicate and fragile mechanism there would be a large amount of wear and tear and breakage due to expansion and contraction, some of these reflectors being as large as thirty feet in diameter. In those days it cost about $1000 per horse-power to utilize solar energy and it was impossible to construct a plant larger than ten horse power. Such engines were, of course, practically worthless, though scientifically perfect.

"The principle of my 'hot box' eliminates entirely all the disadvantages of the old type solar engine. In the first place, the cost of construction and installation is no more than that of a good modern steam plant of the same power and it can be made any size so that there should be no difficulty in constructing a large plant. In the second place, the solar plant being of simple mechanism the wear and

tear is only a fraction of that of an ordinary steam plant and, last but not least, the fuel costs absolutely nothing.

"Of course, a water power plant, also costs nothing for fuel, but when its first cost is compared to that of a solar plant, it will be found to be much greater and the wear and tear on the penstocks and turbines greatly increase its cost of maintenance over that of the solar power plant. There is, however, one difficulty met with in the solar engine and that is that even in tropical climates, power is only available for one-third the total time, which would necessitate the use of accumalators for continuous operation.

"For pumping water for irrigation purposes the solar engine possesses decided advantages, as without any attendance, except an occasional oiling, it will pump as long as the sun shines. Thus with artesian wells and solar engines, irrigation will cost very little."



Direct Acting Solar Engine located at Tacony, Philadelphia

Even though this solar engine should be recognized as practical and economical, it would still be open to the objection of being available for not more than eight hours a day, and on sunny days only. Mr. Shuman proposes, however, to use solar power for liquefying air, which, in its turn, is to be produced so that it will replace gasoline and other fuels and become a source of motor power.

To do this he proposes to build solar power plants in the tropics, where humidity is scarce and sunlight abundant, compress indefinite amounts of the atmosphere there, and ship it in bulk.

So confident is the inventor that he is on the right track that he now has engineers looking over sites in Arizona, Havana and Florida, while his son is making observations in Egypt, where he hopes to get an order from a new trolley company to install a solar power plant.

"This trolley business in the tropics is perfectly feasible," said Mr. Shuman. "A double plant can be built for using coal or solar power. During the day the fires can be banked, and solar power used. It will cut the coal bill in two, which is a big consideration in hot countries, where fuel must be imported at great cost.

"But the liquid air idea is the best. Liquid air is the best storage power known. This has been proved in England, where it is used to run automobiles. Automobile experiments have also been made in Boston. The only objection is the cost, as the price is about $1.20 a gallon in bulk. Now, if by using solar energy to liquefy the air it can be sold for a few cents a gallon, it may probably displace all other sources of motor power for automobiles and light engines."

In conclusion, Mr. Shuman said, "Of course, there will be some who will think I am a fanatic and consider my scheme of the 'wildcat' type, but I feel confident that many who think it over carefully will consider it both logical and practical. All of the coal we are now burning is merely the stored-up power of the sun delivered to the earth many years ago. We dig far into the ground to obtain this, whereas the sun is delivering an equal power free, every day, right at our doors and the proper means for receiving this power and using it to advantage is the solar engine."

ENGINEERING IN A NUTSHELL

Answers to Questions That Won First Prize in the Michigan N. A. S. E. Contest

By Edward J. Rose.

Subject No. 1—Steam Boilers.

The subject of steam boilers has a very wide latitude. The most important requirement is that the boiler, regardless of shape or form, shall possess sufficient strength to resist the maximum pressure to which it will ever be exposed, after which comes sufficient grate surface for the combustion of the necessary quantity of fuel under any circumstance, sufficient heating surface to evaporate the necessary quantity of water, it must contain a sufficient supply of water and steam so as to prevent undue fluctuation, and it must afford convenient facilities for cleaning, repairs, and the renewal of any of its parts.

Nothing must be left undone to secure uniform expansion. The shell and all exposed portions of a boiler are in constant state of expansion and contraction, due to changes of temperature, and the design should be such as to allow these changes to take place without causing the boiler to leak. It is because of this high rate of expansion that from five to ten hours must be taken to raise steam in shell boilers. In an ordinary water-tube boiler steam may be raised in much less time, and that is one of the special advantages of the water-tube boiler. In the naval service the ability to raise steam promptly, taken from data of tests on the "Cincinnati," shows what has been done in this direction.

Fires were started under a cold boiler, lightwood being used, and the blower running (closed stockhold system). Steam formed in five minutes, and in twelve minutes and forty seconds had reached a pressure of 215 pound gauge. Now to raise steam in cylindrical boilers without special appliances for circulation, and without endangering its complex structure, requires from five to ten hours.

Now the engineer who has boilers under his charge must use eternal vigilance and must very carefully examine all parts. All seams, heads and tubes should be examined for leaks, cracks, corrosion, pitting and grooving, detection of the latter requiring, in some cases, the use of a magnifying glass. Uniform corrosion is wasting away of the plates, and its depth can only be determined by drilling through the plate and measuring thickness, afterwards plugging the hole. Pitting is due to local chemical action and is readily perceived. Grooving is usually due to buckling of the plates when under pressure and frequently to careless use of sharp calking tools. Seam leaks are generally caused by overheating and demand careful examination, too much care cannot be given to this particular point, as there may be cracks under the rivet heads. If such cracks are discovered, the seams must be cut out and a patch riveted on.

Loose rivets should be carefully looked to and should be cut out and replaced. Pockets, bulging and burns should be looked for in the fire-box; the former are not necessarily dangerous, but if there are indications of their increasing, they should be heated and forced back into place, or they should be cut out and a patch put on. The burned spots should be cut out and patched. Stays and braces and their fastenings, should be carefully examined and defective ones replaced. The shell of boilers should be thoroughly examined externally for evidence of corrosion which is so liable to set in on account of dampness, exposures to weather and leakage. Beware of those small leaks around your boiler, as they will in a very short time waste away the shell flues or heads. The mud drum and its connections are very liable to corrosion, pitting and grooving, and should be examined as carefully as the boilers. The brick work should be free from air holes, as they decrease the efficiency of the boiler and are liable to cause injury to the plates.

In the writer's twenty-six years of management and care of steam boilers of different types, and in his close observation of the smallest detail in connection with boilers, he has found that vigilance is not only necessary to the safety, but to the efficiency of the boilers above all the other parts of the steam plants.

At the present time boilers are inspected by public inspectors or by insurance companies, but the engineer in direct charge must not think that because his boiler was inspected by others that he can relax from his own usual careful inspection. He must not forget that some small defect may happen at any moment, and that if not detected it may become very dangerous before the next inspector comes around. Ninety-five per cent. of all boiler explosions are due to some defect which is either overlooked or which cannot be detected upon inspection. All the expert knowledge in the world cannot tell us whether there is a crack underneath the longitudinal seam of the horizontal lap seam tubular type of boiler, and yet when the boiler was built such a crack may have been started, as the plates are rolled as nearly circular as possible, and overlapping ends must be pounded down by heavy hammers while the metal is cold, and the rough usage may start a crack. Now, after the joint is completed, the plates do not form a true circle, but when in use the pressure forming a circle distorts the plate at the stiff joints, and continues bending back and forward with the pulsation of the boiler, which deepens the crack until it extends clean through the boiler. So if the engineer should discover the slightest sign of weakness in those seams, he should not under any circumstances start the boiler until it is thoroughly repaired. A crack in any portion of the boiler makes it unsafe to operate.

In reference to the efficiency of steam boilers, the engineer in charge must make himself thoroughly familiar with the conditions that he has to contend with. If he finds that the shell and flues of the boiler are getting covered quite often (say in a run of twenty-four hours) with unconsumed carbon, then the combustion is poor, and no time should be lost in getting the right mixture of air. There is more loss in this than in the scale that is deposited from the water inside. The loss must be measured by the incomplete combustion as well as the loss of heat caused by this insulation of the tubes and shell. The volumes of black smoke that

are seen issuing from our smokestacks is a sure sign of very green fires and incomplete combustion caused by the improper mixture of air or carelessness on the part of the operator. Scale, or the minerals which constitute it, is another great enemy of boiler efficiency, so when we sum up all the conditions that tend to counteract the heat units in the fuel, we find that the most important duty of the engineer is to see that the boiler is kept clean inside and outside, and with a boiler that is constructed properly they should not fail to give satisfaction.

SUBJECT NO. 2—THE STEAM PUMP, ITS TROUBLES; ALSO, HOW TO REMEDY SUCH TROUBLES.

A steam pump is a machine with a hydraulic attachment for raising or forcing water or other liquids. We do not mean that our pumps suck the water up. We know that it is the atmospheric pressure that presses the water up the so-called suction pipe after the pump has relieved the column of air.

To do this without trouble the pump must be in perfect condition, the cylinder and pistons and all joints perfectly air-tight and a check or foot valve at the lower end of suction pipe. We can often avoid trouble by removing packing before it gets too hard. It is also economy to do so, rather than to draw up the gland and cause undue friction in outside plunger-packed pump. This is important, and too much care cannot be taken to keep the packing soft. If flax is used it will pay to remove it occasionally, and clean it and soak it in good tallow or a good engine oil.

The writer had trouble with a large fire pump, the water passing by the inside packed piston as the pump was under pressure governed by an automatic governor; no water was used only in case of fire. The pump should, in this case, just move if it did not have a leak somewhere. In this case the leak was found and the remedy was to put a lining of thin brass under the packing and stop the leak, as well as saving the packing.

The same remedy was applied on a boiler feed pump that had worn large in the middle of the water cylinder, only on this a brass spring in the shape of a sleeve like a snap piston ring was put under the packing. This avoids all unnecessary friction caused by the packing screwed up very tight.

Another troublesome thing is a leak past the sleeve from one chamber to another, and it is one of the last things we think to look for, but they are to be found in some pumps and the result is a great loss in pump efficiency.

If the pump rods are worn down by the packing being too hard (leakage will cause it also) the pump sometimes sticks at the end of the stroke. That trouble occurs after packing, because the gland is farther out from the stuffing-box. Another thing that is hard on packing is the hole at the bottom of stuffing-box in some cases being too large. To remedy this turn up a ring of babbitt to fit the rod and stuffing-box. Split it and put it in the bottom of the box. Keep the valves and seats smooth, as there is a great loss in the water passing back through them. The steam pump is very wasteful when there is a loss of slippage in the water end.

There will not be so much trouble with pumps if they are packed properly, as one-half of pump troubles is in the packing, inside and out. A good thing to save time and trouble is to get the correct measurement of the rods and stuffing boxes of all pumps and make a templet turned to size of rod. A piece of hard wood will do, and eight or ten sizes may be put on it with numbers corresponding with number of pump rod. The writer has one with eight sizes and one with seven, with a schedule on paper showing the make of pump, number of rings that each stuffing-box takes, and size of packing.

Now, when a pump wants packing, we get the schedule and find (say No. 3) is a Worthington pump, and it takes ½ packing and five rings. The templet is then put into the vise and the rings are cut to a perfect fit the size of rod. In making the ring in this way the job is done with half the trouble and half the time, while the other fellow is measuring the packing around a hot rod and sometimes steam blowing on his fingers.

SUBJECT NO. 3—CARE AND MANAGEMENT OF THE DIRECT AND ALTERNATING CURRENT DYNAMO.

If proper care is taken of the electric generator, good management is shown. Cleanliness of all parts of the dynamo is absolutely required to get satisfaction from the machine, whether it is alternating or direct. The commutator and brushes, if kept in proper condition, will reduce the wear to a minimum. Any sparking whatever indicates a bad condition of the commutators or defective adjustment of the brushes.

What causes sparking? It is our duty to find out. Have we got the brushes set at neutral point? If not, let us adjust them by turning the yoke around until they are, or if we cannot do that, count the segments and even the brushes up, and make them come at diametrically opposite points. We must see that the brushes have full bevel on the circumference of the commutator, and, if there is still sparking, try a little more pressure on the brushes, and clean the dirt from them; and if that will not stop it, then we must look for a high, low or loose commutator bar. There may be a connection between armature coil and commutator bar loose, or a section short-circuited, or a cross on outside system, or short circuit, with copper dust around armature coils or commutator sections. These are some of the principal features which cause sparking, if the dynamo is not overloaded.

Dynamos may be subjected to some serious disorders. One is by overloading the armature, causing the insulation of the coils to burn. If the coil is rendered useless it can be fixed temporarily by disconnecting from commutator, then insulate the ends with tape and then join the two adjacent bars to which the coil was connected, with a wire same size as the armature wires. The machine will run this way, but should be repaired at the first opportunity.

A ring of fire around the commutator is caused by small particles of copper getting between the bar of the circuit. Remedy for this is, clean the commutator carefully and do not allow the brushes to cut and scratch it.

Great care should be used in throwing dynamos in circuit with others running in parallel. Be sure the voltage is the same and then let each dynamo have its full share of load, and be sure the speed of the dynamos are right and that all connections have good contact. Be sure the

armature is perfectly in the centre of pole pieces. If they are not, it causes unequal magnetic induction at different points and causes bad sparking.

Grounds on lighting systems should be removed at once, as they are not only dangerous, but, if heavy, will waste a considerable amount of power.

The alternating current has important advantages wherever electric power has to be conveyed over a long distance. For these reasons the use of the direct-current system is limited mostly to cases where the current is transmitted over short distances.

Alternating current dynamos depend for their operation upon the same principles of magnetic induction as do the continuous current, and the engineer in charge must appreciate the importance of cleanliness and good management with direct-current or alternating-current systems, so as to run them sucessfully.

SUBJECT NO. 4—THE DUTIES OF AN ENGINEER.

It is his duty to understand the working of his boilers and engines with exactness and accuracy, in view of the vast amount of property and valuable lives that depend upon him. He should be able to discover any defect that may occur on his boilers, engines and pumps, or any machinery under his charge; be able to take up lost motion or take apart and put together the different parts of an engine.

It is the duty of an engineer to be punctual and to keep his boilers and all attachments clean, and attractive. It is his duty to know all the details of his work and to do with exactness every duty imposed upon him, to keep cool and brave in the presence of unexpected conditions that may occur around the steam plant.

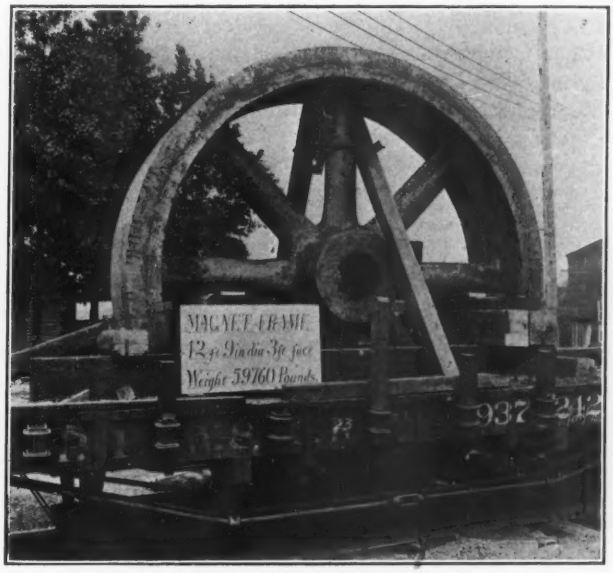
It is his duty to attend at once the first knock in an engine, the smallest leak in a boiler and the slightest variation from the regular smooth running of the plant.

He is in duty bound to study the interest of his employer, who trusts him not only with this valuable machinery but also in many cases with the selection of new machiery and supplies.

In regard to supplies, the engineer should be strictly honest and not show any favor to anyone but let them stand upon merit alone and keep a neat, clean and honest record of all things pertaining to his plant. In so doing he will have the respect and trust of his employers not only for keeping the machinery running without delay, as it is his duty to do, but for being a fair-minded and faithful, trustworthy man and an engineer.

The Value of Large Steel Castings in Electrical Construction.

It is a very important matter in the design of electrical machinery that the magnetic path shall have the least reluctance possible. This is attained in practice by lessening the number of joints in the magnet field, making the air-gap between moving parts as small as possible, and increasing the permeability of the circuit. Steel is the best metal that can be used for that purpose as thousands of lines of force can be crowded through it without perceptibly increasing its reluctance, and it can be cast in any shape desired which obviates the use of joints in the magnet circuit. The accompanying illustration shows a large steel casting weighing exactly 59,760 pounds, which is mounted on a specially prepared car for shipment. It was made by the Federal Steel Foundry Co., of Chester, Pa., for the General Electric Co., of Canada. It is 12 feet 9 inches in diameter with a 3-foot face, and owing to lack of sufficient head room on the railroads over which it was shipped, it had to be sunk below the platform of the car. Besides possessing the above electric advantages, steel



Large 30-Ton Steel Casting for Magnet Frame

castings are very much stronger than cast-iron, which has caused them to be used for all the purposes for which cast-iron was formerly used, especially for fly-wheels, centrifugal pump casings, engine cylinders and other uses where strength is the first factor and where cost is a secondary consideration—steel castings costing considerably more than iron-castings.

Packed Joints.

A gas engine user gives the following method of packing exhaust chamber joints:

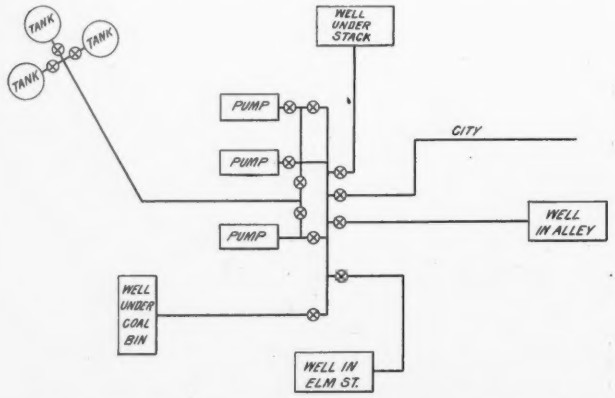
First, I cut two packings out of common asbestos paper; then separate them, and cut a packing from screen wire or rather coarse gauze wire; then clean both surfaces of everything. Wet in water one of the sheets of asbestos, place on the bolts, being careful not to tear; then place on the wire packing. Now wet the other asbestos sheet and place it over the wire, and in places where I wish to remove the plate occasionally, smear a little grease on the plate and place on, drawing all the nuts up together and rather firmly. The nuts should be tightened a part of a turn, one after another. If one is drawn clear up, leaving the others all loose, it will perhaps spring the plates so that a tight joint cannot be made.

Packings put on this way will last a long time if you are a little careful in putting them on first. Then in removing the plate, leave the packing on studs, as it will readily separate from the plate.—*The Gas Engine.*

A COMBINED HEAT, LIGHT AND POWER PLANT

A Steam Plant at Lockport, N. Y. which Competes with Niagara

Owing to the apparent cheapness of water power, it may seem, at first thought, as if steam could not compete with it as a motive power for generating electricity, but, in reality, steam-driven electric plants are lively competitors of the hydraulic plants in many places. One of these steam-driven plants, which is thriving not very far from the mighty Niagara, is the plant of the Economy Heat, Light and Power Co., located at Lockport, N. Y., and the inhabitants of this progressive



Feed Pump Arrangement in Boiler House of the Economy Heat, Light and Power Co., Lockport, N. Y.

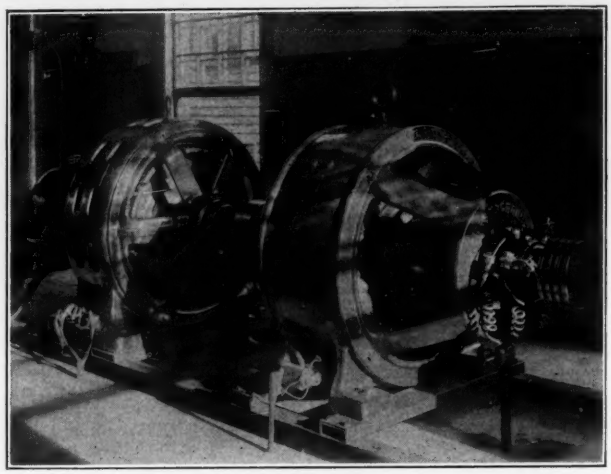
town of 16,000 inhabitants seem very well satisfied to receive their electric light and power from the reciprocating engine, rather than from the water turbines on the banks of the Niagara, only a few miles distant. The matter of price and continuity of service are the principle factors in which a public service corporation must give satisfaction to its customers, and in the combination of these two, the steam-driven plant seems to have the advantage in this particular locality. At the present time about 80 per cent. of the commercial lighting load in Lockport is carried by the steam plant, principally because they furnish 60-cycle current in place of the 25-cycle current sent from Niagara, the greater frequency being better for illuminating purposes, as the 25-cycle is hardly yet adaptable for incandescent lamps of ordinary make.

The steam plant is able to distribute electric current to its patrons at the low rate of 3 cents a kilowatt-hour to large consumers, because, in the winter, it sells its exhaust steam to many of the same people who buy the electric current, and, at the present time, about 350 customers use this steam in their residences, factories, public halls and churches.

The steam plant at Lockport was originally used as a live steam-heating plant, but with the increased efficiency of insulation, and after a series of exhaustive tests, conducted by and under the supervision of the American District Steam Co., it was found that but a comparatively small percentage of the heat value in the exhaust steam would be lost, thus enabling the engines to use the same steam that was used for heating, producing a double income. It, therefore, became possible to furnish electric current to the public at a sufficiently low price to compete with the great Niagara turbine plants, the transmission wires from which pass directly through the town.

The generating station is a large red brick building which is divided in two parts by a heavy brick wall, one part being used for the engine room, and the other part for the boiler room. The boiler room is 132 feet long by 46 feet wide, and contains all the modern facilities for the economical generation of steam. The bituminous coal is brought to the station in railway cars to a siding where it is dumped in a coal crusher driven by a 20-H. P. motor, and is conveyed by a motor-driven belt conveyor to the top of the boiler room, where there is a 150-ton storage bin. From this bin, the coal is dropped, by means of shutes, to a coal car which runs along overhead tracks the full length of the boiler room. One portion of this track is equipped with track-scales, so that every portion of coal used is weighed. After being weiged, the coal is dumped into 50-ton bunkers above each boiler. If for any reason, the belt conveyor should become broken, the coal can be dumped from the coal crusher into the station car which can run on tracks in basement to an elevator which raises the car to a level above the boiler bunkers, the coal being weighed before dumping, as before. For handling the ashes, this latter method is used. The ashes are dumped into the car in the basement which is run on the elevator, lifted to the scale platform, weighed and run out on a trestle at the back of the building, and dumped into the yard.

The boiler room contains six water tube boilers, two of them being of the Heine type, 365 horse-power each, and the other four of the Stirling type, two being 250 horse-power each, and two 150 horse-power each. They are equipped with Dutch ovens in which are located Murphy automatic stokers, fed from the coal pockets above by gravity pipes. The boilers are equipped with Reliance gauge columns, and two of them are equipped with Squires feed-water regulators, the Heine boilers being equipped with Ashton pop safety valves.



Rotary Converter used for Supplying the Direct Current Load

The fuel gases are passed through two Green economizers before passing to the stack, which is 7.5 feet in diameter and 155 feet high. The economizers are equipped with the usual cleaning devices, and are guaranteed to save 12.5 per cent. of the fuel used.

There are five sources from which the boilers can obtain their feed-water, four wells and the city supply. Before being pumped to the boilers, the feed-water is treated in three feed-water tanks, each having a capacity of 130,700 pounds each. After being chemically treated according to the Atlas Purifying System, the water is pumped through the economizers and enters the boilers at a temperature of about 220 degrees.

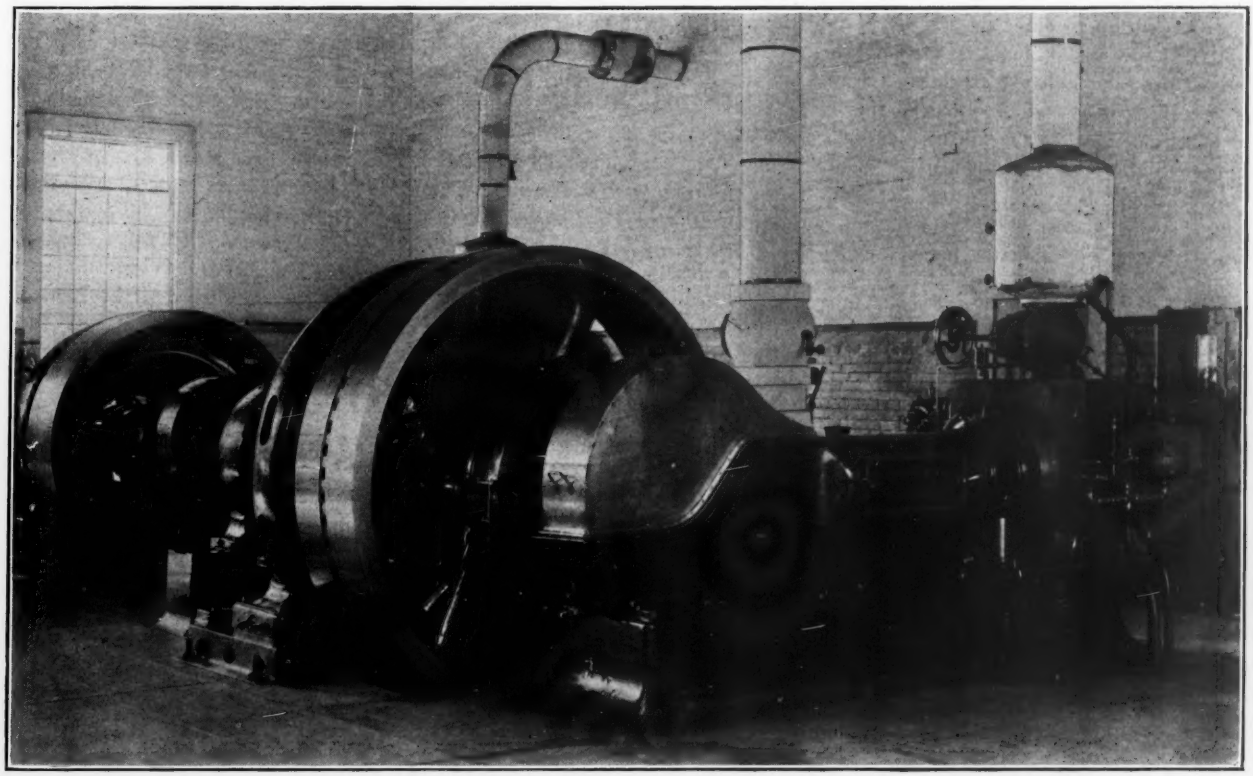
There are three feed-water pumps used, one outside packed Buffalo pump, 10″ x 6″ x 10″; one 9″ x 5½″ x 10″ Worthington pump and one 8″ x 4″ x 8″ pump of the same make. Each pump is equipped with a Squires pump governor and a Hills-McCanna force-feed lubricator.

The steam from the boilers goes to a header which feeds steam, at about 150 pounds pressure, to the engines in the engine room. This room is 37 feet wide and 66 feet long, and contains two Fleming four-valve engines direct connected to two Westinghouse generators. The larger engine has a cylinder 19″ x 19″ and runs at 200 revolutions per minute, the small engine being 16″ x 15″, running at 225 revolutions. The generator on the larger engine is of 250 kilowatts capacity, and the smaller generator has a rated capacity of 165 kilowatts. The engines are equipped with Hills-McCanna force-feed lubricators, the oil for which is first filtered through cross-oil filters.

Three-phase alternating current is generated at 2,200 volts, and each generator has its own exciter mounted on the end of the shaft, the exciter for the larger unit having a capacity of 12½ kilowatts at 125 volts, the smaller exciter having a capacity of 10 kilowatts. From the generator, the alternating current goes to the switchboard which is built in six panels, two being for the control of the generator units, one for the exciters, one for the rotary converter, one for the alternating-current distribution system, and one for the direct-current system. The direct current is used principally for the motor load on the lines, the alternating current being used principally for lighting.

The switchboard is equipped with two voltmeters, a Tirrell voltage regulator and a Westinghouse graphic meter. The direct panel is equipped with two circuit breakers, a rheostat, a voltmeter switch, two ammeters, and four two-pole switches, which control the various circuits. The panel which controls the rotary converter is equipped with an ammeter, a power-factor switch, a plug switch for connecting up the station voltmeter, an oil-break switch, and an autostarter. The exciter panel is equipped with two ammeters, a voltmeter, a rheostat, a plug voltmeter switch and two three-pole switches for the exciters. The alternating distributing panel contains two oil-break switches for the feeders, and each generator panel contains three ammeters, one for each phase, a rheostat for the field, a field switch, a plug voltmeter switch, and an oil-break main switch. The switchboard is also equipped with a kilowatt-hour meter, which records the station output.

The rotary converter, which is used for supplying direct



Engine Room of the Economy Heat, Light and Power Co., Lockport, N. Y. The Exhaust Steam from these engines is used to heat the town of Lockport

current to the motors on the line, is a 2,300-volt, three-phase, Westinghouse motor, driving an 85 kilowatt 250-volt direct-current generator. For starting purposes, a 10 horse-power induction motor, connected to the shaft on the motor end, is used which brings the converter up to its normal speed of 750 revolutions per minute, when it is thrown on the alternating-current lines. The three-wire direct-current system of distribution is used, balancing coils being used to balance the two sides of the circuit.

For heating the town of Lockport, the exhaust steam from the engines are used, the ideal condition being attained when the electric load requires as much steam as the heating load demands. An average of 5 pounds back pressure is maintained on the heating mains, but should the demand for steam exceed the supply from the engines, a Squires automatic reducing valve, placed between the boilers and the heating main, allows live steam to enter the main. Should there be an excess of exhaust steam, due to a large lighting load and a small heating load, the exhaust steam is released by means of a back pressure valve, which prevents the waste of live steam, and which opens when the pressure exceeds the back pressure required to close the reducing valve.

After passing from the station, the steam enters the underground steam mains, which consist of wrought-iron pipe spirally wound with asbestos paper, and enclosed in a round tin-lined wood casing, having a shell 4 inches in thickness, with a dead-air space of, at least, one inch between the tin and the asbestos covered pipe. The casing is made from selected timber into radial staves, with groove and tongue running the full length of the stave, the staves being firmly banded together with 3/16-inch galvanized steel wire spirally wound around the casing, the outside being covered with asphaltum, pitch and sawdust.

Throughout the underground heating system, which has a total length of about seven miles, the farthest consumer being about 1¼ miles from the station, devices for taking care of the contraction and expansion and achoring are placed about 50 feet apart. These devices are also used for making service connections, and they act as separators, which prevent any condensation from passing into the building to be heated.

The charge for any given heating service is obtained by weighing the amount of condensation from the building which is heated. This is done by means of specially designed traps and meters, which measure the water and discharge it into the sewer or hot well. This condensation is not returned to the station owing to the low heat value of the condensed water and the compartively great cost of laying a return main.

The successful operation of this highly economical plant is entirely due to the American District Steam Co., of Lockport, N. Y., who installed the heating system with all its numerous appliances, these being manufactured by them especially for this purpose. A. W. Wickes is superintendent of the plant, and Geo. G. Derby is chief engineer.

THE INERTIA GOVERNOR

How the Inertia, Combined With Centrifugal Force, Secures Close Regulation

By R. T. Strohm.

The inertia governor derives its name from the fact that it uses the inertia effect of a weight to cause regulation of the valve motion, and hence of the steam distribution. To understand just what this inertia effect is, therefore, it is first necessary to know something about inertia itself. According to physics, inertia is that property of a body whereby it tends to continue in motion, if it is in motion, or tends to stay in a state of rest when at rest. It expresses the inability of any body to change its direction of motion or its rate of motion without the action of some external force.

Each one of us is familiar with this property of bodies and has seen it manifested countless times, although some may have failed to recognize it. Place an ordinary calling card across the top of a tumbler, and on the card lay a coin. Then snap the card sharply with the finger, in a direction parallel to the top of the glass. The card will fall outside the glass somewhere, and the coin inside the glass. Here, then, is a homely illustration of the principle of inertia. The friction between the card and the coin was very slight. Consequently, when the card was struck and set into motion very quickly, this motion was not communicated to the coin. The coin remained in its original position because of its inertia; that is, because it could not start by its own powers, and because no outside force acted on it. Hence, as soon as the support of the card was removed it fell downward into the glass.

Again, take two blocks of wood, as shown in Fig. 1, and stand the longer block *a* upon the flat piece *b*. Now, very slowly, move the block *b* in the direction of the arrow, and it will be found that the two blocks will move together, the block *a* remaining standing on the other. This is due to the fact that the friction between the two is so great as to communicate an external force to the block *a* and thereby set it in motion at the same rate as *b*.

With the blocks in the same relative positions as before, draw the lower one very quickly in the direction of the arrow *c*, Fig. 2. The result is now quite different from that of the previous experiment. The block *a* no longer remains upright, but topples over backward in the direction indicated by the arrow *d*. In this case the inertia of the block *a* prevented its being set in motion as rapidly as *b*, with the result that it fell backward. For, while the bottom tended to go with *b*, on account of the friction at that point, this force was not instantly transmitted to the whole of the block *a*, and the top lagged behind the bottom, causing the block to fall.

As a third test, place the blocks as in Fig. 1, and move the lower block, slowly at first, and then with gradually increasing speed. Then suddenly stop. The result is indicated in Fig. 3. The top of the block *a* swings forward in the direction in which the two blocks had been moving just before the lower one was brought to rest. And this

action is due to the inertia of the block *a*. Friction at the base of the block quickly brought that part to rest. But the upper portion, being in motion, tended to continue in motion in the same direction and at the same speed as before, and as a consequence the block fell forward.

Thus, these experiments have established three facts: (1) When both blocks move at the same speed there is no relative motion between them. (2) When the lower block moves more rapidly than the upper one, the upper one falls backward. (3) When the lower one moves the slower of the two, the upper block falls forward.

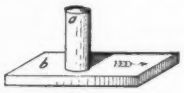


Fig. 1

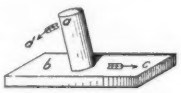


Fig. 2

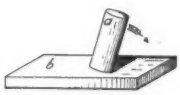


Fig. 3

These conclusions have been drawn from observations of bodies moving in a straight line. But they apply equally to circular or rotary motion. Take, for example, the arrangement shown in Fig. 4, in which a pulley *a*, keyed to a shaft *b*, carries on one of its arms a bar *c*, weighted at the ends, as *d* and *e*, and free to swing on the pivot *f*. Assume that the pulley is being rotated at a uniform speed by the shaft *b*. Then the bar *c* will go around with the pulley, without changing its position in relation to the pulley. That is, there will be no tendency of the bar to swing or turn on its pivot *f*. In other words, all parts revolve about the shaft *b* at the same angular velocity.

But now suppose that the rotation of the pulley *a* is suddenly checked, and observe the effect that will result. Previously to the decrease in speed, the weights *d* and *e* were revolving about *b* as a centre, and at the same rate as the pulley. But when the pulley slows down, the weights tend to keep on moving in the original direction and at the same velocity. The result is that each weight swings forward in the direction of rotation of the pulley, thus turning the arm *c* on the pin *f*.

A reverse effect is produced if the rate of rotation of the pulley is increased. In such a case, the pulley runs ahead of the weight arm, or, what is the same thing, the weight arm lags behind the pulley, and the result is a turning of the arm *c* on its pin *f*, but in a direction opposite to the direction of motion of the pulley. The movement of the weight arm on its pin as the speed of the pulley changes is due to the inertia of the arm and its weighted ends. Furthermore, the least increase or decrease of speed of the pulley will cause a corresponding change in the relative positions of the arm and the pulley. It is therefore evident that if the pulley were fixed to an engine shaft and the weight arm connected to the valve gear by suitable mechanism, it would be possible to utilize the movement of the arm to regulate the valve motion and thereby control the speed of the engine.

This is precisely what is done in the inertia governor as applied to high-speed steam engines. Fig. 5 shows the principal parts of such a governor. First of all, there is the governor wheel *a*, to which the governor parts are attached. The wheel is fastened to the main shaft of the engine, the centre of this shaft being at *b*. A pin *c* is firmly fixed in the wheel just a short distance beyond the edge of the hub and on this pin is hung the weight arm *d* of the governor. This arm carries heavy weights, *e*, *f*, at its ends. At *g* there is a slot in the weight-arm casting into which fits a bolt *h*, to which is attached a strong steel spring *i*, the other end of the spring being fixed and held by a bolt and nut *s* to the arm of the wheel. No eccentric is used on this governor. Instead, a pin *k* is set into the weight arm so as to be to one side of the shaft centre *b*. As the wheel revolves, therefore, this pin *k* travels around the centre *b* in a circle, and as the valve rod is fastened to the pin *k*, it receives a reciprocating motion that is transmitted to the valve.

The amount of movement of the valve is not constant, however. Any slight change in the speed of the wheel results in a swinging movement of the weight arm on its pivot *c*, and a consequent shifting of the position of the pin *k*, either closer to or farther from the centre of the shaft. Thus the valve travel is either shortened or lengthened, thereby changing the cut-off to suit the altered load on the engine.

This governor, to be exact, is not simply an inertia governor. It also uses centrifugal force to secure the desired action. If the weight arm *d* were placed on the pin *c*, and no other attachment to the wheel were made, then the governor would be very unstable. Every sudden change of speed would cause the weight arm to swing through its whole range of action from no cut-off to latest cut-off. The pull or thrust on the pin *k*, due to the friction of the valve on its seat, would also disturb the position of the weight arm. Furthermore, it will be seen that the weight arm is not pivoted at the middle. Therefore, one end is heavier than the other, and when the arm is in a horizontal position

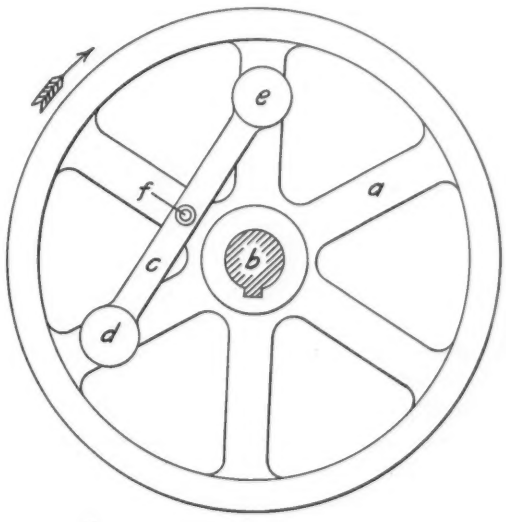


Fig. 4

the heavier end tends to fall. Should the arm be unrestrained, therefore, this action would seriously interfere with the desired operation of the governor.

To compensate for these disturbing influences, the heavy steel spring *i* is attached to the weight arm and the wheel. Thus the weight arm movement is dampened or restrained to some extent, so that, while still able to respond to sudden slight changes of load, it cannot swing from one ex-

treme to the other whenever the slightest speed variation occurs.

Reference has already been made to the fact that centrifugal force aids largely in the governing action. This is explained as follows: Since the weight arm is not perfectly symmetrical, its centre of gravity lies at some point *p*, and in all discussions relative to the motion and action of the arm, it may be assumed to have all its weight concentrated at the point *p*. Now, this weight, revolving rapidly about the shaft *b*, would set up centrifugal force acting in a line *b p* radial from the shaft centre and tending to throw the weight arm outward along the direction *b p*. But since the arm is pivoted at *c*, the result of the action of centrifugal force on the line *b p* is to turn or swing the arm on the pin *c* in a left-hand direction. The spring *i* resists this turning action, since it is so fastened as to tend to swing the weight arm in a right-hand direction, and the spring is so designed and attached that at a given speed the spring pull and the centrifugal force produce equal and opposite effects upon the weight arm. Thus, if the speed of the engine gradually increases, the centrifugal force grows greater and the weight arm turns left-handedly, on the pin *c*, thereby stretching the spring until its increasing resistance prevents further turning and the two are balanced. When the speed falls, the centrifugal force decreases and the spring pull then being the larger, the spring shortens until the two are again balanced. Thus a uniform speed of the engine is secured under varying loads.

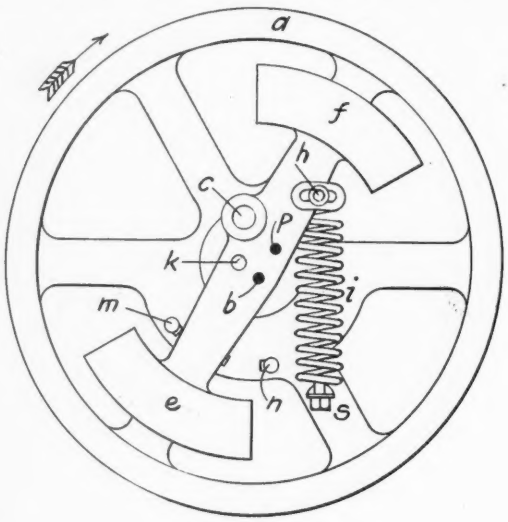


Fig. 5

This type of governor possesses some distinct advantages, and one of these is its simplicity. The parts are very few in number, and consequently there is a minimum chance for derangement. The combination of centrifugal and inertia forces to secure close regulation makes this type of governor an excellent one. The inertia element insures the engine against sudden fluctuations of speed such as might occur during a single revolution, due to change in the load or the steam pressure. This has already been explained. The centrifugal force developed prevents changes of speed from extending over a number of successive revolutions, since the slightest increase in speed increases the centrifugal force and causes the valve travel to decrease, and cut-off to occur earlier.

A disadvantage lies in the fact that the gravity action is unbalanced. That is, the tendency of the heavier end of the weight arm to fall is not counteracted, and this will result in a constant motion to and fro of the weight arm unless some provision is made to dampen it or minimize it. It has been found that if the pin *c* supporting the weight arm is made large in diameter, the friction between it and the arm will serve the desired end and will render the gravity pull of no effect.

Like any other type of governor, the inertia governor possesses means of adjustment whereby the speed of the engine may be made greater or smaller. It must be borne in mind that the inertia effect of the weight arm renders the governor sensitive to sudden changes of speed, while the balance existing between the turning effect due to centrifugal force and that due to the spring pull determines the speed, in revolutions per minute, at which the engine will run.

The ends *e* and *f* of the weight arm are so made that they can be made lighter or heavier by the removal or addition of plates, thus changing the sensitiveness of the governor. To change the speed of the engine, more than one method may be used. Since the effects of the spring pull and centrifugal force must balance, to give a constant rotative speed, it is evident that if the spring pull is increased, the engine will need to go at a higher speed than before, to balance the increased spring pull with the governor position unchanged. Consequently, to increase the running speed, the tension of the spring may be increased by means of the nut at *s*. Or, the number of effective turns of the spring may be reduced. The bolt *h* may be moved in the slot *g* in a direction toward the suspension point of the weight arm. This will decrease the arm of the spring pull, and consequently the engine will run at a greater speed when balance is again restored.

To cause the engine to run at a lower speed, alterations just the reverse of the foregoing must be made. Stops *m* and *n* are provided to prevent the weight arm from swinging through an excessive arc when the engine is starting or while it is slowing down.

Aluminum Tubes for Boilers.

Under certain conditions wrought iron and steel boiler tubes deteriorate very rapidly, so that various means have been taken with only partial success to prevent it. Wrought iron and steel tubes, variously coated, and brass tubes have been tried as well as galvanized iron tubes, but all with the same unsatisfactory result. Experiments have shown that vulcanizing and galvanizing do not materially increase the life of the tube, and while brass tubes have a longer life, their first cost makes them prohibitive. Experiments are being made with nickel and aluminum tubes, and it is said that tests made in Germany have shown fairly satisfactory results with the latter metal.

Exclusive of Great Britain, the United States in 1906 produced more coal than all the other countries of the world combined.

A TALK WITH A CHIEF ENGINEER

Practical Pointers on Ice Machines and the Theory of Ice Making

By William Kavanagh.

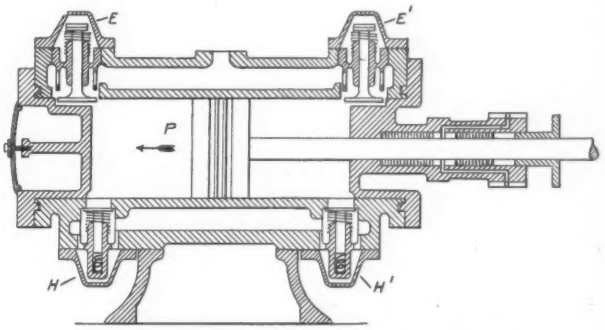
Talk No. 4.

The Chief having telephoned that Kingsley would make a call at 3.30 P. M., I replied that I would be over to his plant at the appointed time and form one of the company. On entering the engine room, I found Kingsley seated at the Chief's desk, and after passing the usual compliments, I asked Kingsley where the Chief was, and Kingsley replied that the Chief was over in the office and would be back in a few minutes. In a little while the Chief arrived, saying that he always made it a habit to O. K. the bills in the main office and to transact all business there because such a plan eliminated all suspicions about commissions, etc., and in doing honest business he had gained the confidence of his employers. "I get a good salary here," said the Chief, "and I don't propose to have the slightest suspicion cast upon my department, hence all matters relating to money must be transacted there. I have always insisted, however, that I must be permitted to engage and discharge my help, because I found that when such help was employed at the main office the men were usually insubordinate, and that they relied on the manager to keep them despite my wishes. I found that most of the men hired at the office for my department were practically worthless. By doing the hiring myself, I am better able to judge the men because I usually ask them a few questions in relation to the particular work they are to do and their answers determine whether they are reliable. In this way I have secured reliable help.

"By the way, Kingsley, did you begin to study any algebraic formulae?" asked the Chief. Kingsley replied that he had not had the time, as he was too busy trying to learn about his ice machine and storage battery, and just as soon as he had these things mastered he would begin to look up the matter. "I believe I promised to give you some practical information on these two subjects," said the Chief, "and if you are prepared I will explain them to you in a very practical way." Kingsley said he was prepared and drew from his pocket a pencil and piece of paper to make himself ready to take notes and sketches of anything the Chief might mention or illustrate.

The Chief began his instructive talk by saying that he looked over the catalogue of ammonia compressors which Kingsley sent to him, and that he noticed that all the compressors mentioned therein were of the double-acting type. He called attention to the fact that there was a single-acting compressor on the market, but it was being rapidly displaced by the double-acting type. "Of course," said the Chief, "you are aware of the principle involved with the single-acting water pump. You know one stroke is used up in sucking the water in the cylinder and the other stroke is made use of to discharge the water. Now this is the principle of the single-acting compressor. It sucks in the gas at one stroke, and compresses and discharges the gas with the other stroke. Since it takes two strokes to complete one revolution, it follows that the single-acting compressor or pump will discharge only once in each revolution. With the double acting compressor or pump there is gas or water discharged at each stroke."

"In order for you to understand this, let me draw a sketch of a double-acting compressor." The Chief then drew a sketch of a double-acting compressor as shown. "Let us imagine," continued the Chief, "that the piston P is moving toward the left hand, as indicated by the arrow; then whatever substance is being used as the refrigerant is compressed and discharged through the eduction valve E and out at D. At the same time the refrigerant, after doing its work by absorbing heat from various sources, is drawn into the compressor through the induction valve H. Now assume that the piston has reached the end of its stroke and has discharged all, or nearly all, of the compressed gas. The piston will then reverse and move toward the right; the gas that was drawn in through H^1 will be compressed



Illustrating the Action of an Ammonia Compressor

and discharged through E^1, and during this stroke toward the right, more of the refrigerant gas is drawn in through the induction valve H, which gas will be compressed and discharged through E as in the previous stroke. The compressor is thus made double-acting by the use of four valves, one induction and one eduction valve being placed on each end of the cylinder.

"As will be noticed, when valve E is open, valve H^1 is open, and in a like manner when valve E^1 is open, valve H is also open; that is, the valves on opposite corners are either open or closed at the same time. The eduction valves are fitted with heavy springs and the induction valves are equipped with light springs. The heavy springs should not be strong enough to permit the pressure in the compressor to rise above the condenser pressure, and the light springs should not be heavy enough to permit the back pressure in the cylinder to fall below the suction pressure maintained in the suction line.

"Since the compression of a gas generates heat, some compressors are water jacketed, and in order to absorb as much of the heat of compression as possible, a continuous stream of water is constantly flowing or circulating around the cylinder. This type is known as the 'dry-gas' com-

pressor. There is another type of compressor that is kept cool by means of the wet or humid gas that is drawn into the cylinder, and there is still another type that is kept cool by oil injection. In the latter type, after the compressor is filled with the return gas, the oil is injected between the piston and cylinder head, thus absorbing much of the heat due to compression and at the same time lubricating the piston, piston rod and valves. It also forms a seal which prevents, in a measure, leakage of the refrigerant."

At this point Kingsley wanted to know what kind of oil was used in the compressor. The Chief said it was a light paraffine oil, known as "liquid base." Its use assists materially in reducing friction and in economizing the power required to operate the compressor.

In explaining how one complete cycle of the refrigerant is accomplished, the Chief said: "The gas is drawn into the compressor at a pressure varying from 10 to 30 pounds; it then is compressed to a pressure varying from 160 to 185 pounds per square inch and discharged through the oil separator, through the hot gas line, to the condenser where it is liquefied. From the condenser the liquid is forced into the main liquid receiver from where it is led to the various expansion valves connected to the different refrigerating coils that are used for refrigerating purposes or for ice-making, as the case may be. The liquid on being admitted to those coils becomes saturated with heat, which saturation compels the liquid to expand and form a gas. This gas is then pumped back, compressed, and again liquefied, forming the same cycle as before."

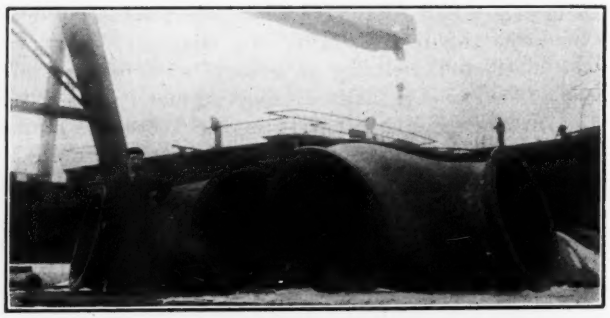
At this point Kingsley wanted to know why the condenser did not become a refrigerator. The chief said it would become a refrigerator if the refrigerant was admitted to it under the same conditions which governed its admission to the expansion coils. "You know," continued the Chief, "that if a boiler be filled with water you cannot make steam, because there is no room for expansion. In a like manner, if the ammonia or any other refrigerant fills the expansion coils, no cold will be produced because the refrigerating media would be unable to expand, boil or form a gas, and since expansion of the refrigerant implies an absorption of heat, it follows that no heat can be taken up by the medium thus employed.

"Anhydrous ammonia is almost universally employed as the refrigerating medium, first, because it is capable of boiling at a low temperature; second, because of its high latent heat of vaporization, and third, it has no corrosive action on iron or steel. When ammonia in liquid form has arrived at the expansion valve, and a small portion of the liquid is admitted into the expansion coils, it almost immediately begins to boil and form a gas because the surrounding temperature of the atmosphere, or water, ice or air, is so high as to cause the ammonia to boil. In boiling, the ammonia absorbs heat from those bodies and parts with its accumulated heat in the condenser. Since the ammonia in the condenser is under a high pressure, and since this pressure prevents the ammonia from expanding, the cooling water flowing over the condenser carries away this accumulation of heat; hence the gas liquefies, and as liquification of the gas takes place, it makes more room for more gas, and in this way the ammonia gas can be pumped out of the ammonia coils and deposited in the condenser or liquid receiver, thus enabling any coil found leaking or injured to be repaired."

As the time was growing short, the Chief said he was sorry that he was unable to finish the subject of ice machines, and as he promised to give us some pointers on storage batteries, he said that he would arrange some evening to devote to this subject. Kingsley and I both promised to be on hand when the Chief telephoned, and, not forgetting to thank the Chief for his kindness, we both departed for our engine rooms.

Large Copper Pipes.

As an example of heavy copper pipe work, the accompanying illustration is particularly interesting, as the pipes are of unusual weight and size. The two copper pipes shown are the main exhaust pipes of the turbine steamship "Creole." Each pipe weighs 2,500 pounds and is 42 inches



Large Copper Exhaust Pipes. Each Pipe is 42 inches Diameter and Weighs 2500 lbs.

in diameter, inside measurement, and 5-6 of an inch thick. Each pipe was made from sheet copper in four pieces, which were brazed together in such a manner as to assume the smooth shape which they now possess. They were made at the copper shop of the Fore River Shipbuilding Company at Quincy, Mass.

Killed While Cleaning Transformers.

David Bowman, a switchboard tender at the McKinley power house, Peoria, Ill., was killed while cleaning some 33,000-volt transformers in the power house. He was using a compressed air cleaning machine and was supposed to have been cleaning only those transformers that were not in operation. It is said that the current of air was allowed to strike one of the live transformers and that the high voltage followed the air current and passed through his body, which was badly burned and blistered.

The power house of the Carrollton Water, Light and Power Co., Carrollton, Kansas, was wrecked by the bursting of a large fly-wheel on one of the engines. It is estimated that the damage done will amount to $7,000.

The fly-wheel of a wire mill engine burst at Waukegan, Wis., causing considerable damage, including the breaking of the main steam pipe.

THRUST OF A CONNECTING ROD

By Charles J. Mason.

Sometimes engineering students find it difficult to understand why it is that the thrust of the connecting rod, or rather against it, is somewhat greater than the force produced by the pressure of steam against the piston rod. They argue that it must be impossible to produce a force greater than the creative one, and therefore the thrust at the connecting rod of an engine cannot be greater than the force acting through the piston rod.

The question is one in which the "resolution of forces"—as the subject is terned in mechanics—is involved. By employing that method it can be proved that the force acting along the connecting rod is greater than the force acting through the piston rod. Without taking the reader through the subject of resolution of forces in the abstract (although it would be profitable and interesting to many) let us use a method of demonstration which will appeal to the reader, and be easily understood by him. This method is, of course, based upon resolution of forces, but when applied to a concrete case it loses much of what might be called "dry" reading.

First, let us consider the illustration contained in Fig. 1, which is intended to lead up to our subject in this article. There we have two poles—clothes poles if you like—A and B, between which a line is stretched, the end at A being secured to the pole direct, while the spring balance is interposed at the other end as shown. The weight C, 50 pounds, is hung on the line midway between the posts. Now by actual experiment it can be seen that the pull in pounds registered by the spring balance exceeds the weight of the suspended weight. The amount of excess will depend upon how much sag there is in the line, the more nearly straight the line is, the greater the excess of pull shown on the balance; the greater the sag in the line, the less the excess of pull as shown on the balance, over that of the weight. This is an experiment that any person can make, that will convince him of one of the facts referred to.

Fig. 1

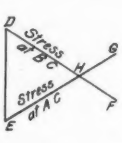


Fig. 2

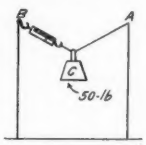


Fig. 3

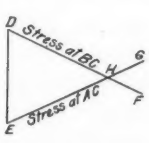


Fig. 4

Diagrammatically, it can be shown just what the stress is in any given case, and how an increase or decrease may be effected by changing the amount of sag in the line. Referring to Fig. 2, we make choice of a scale of 1 inch equals 50 pounds, and draw the line DE near the post A and parallel to it, 1 inch in length. The length of the line DE represents the weight of 50 pounds hanging on the line. Next draw a line (DF) from the point D, which will be parallel to AC, Fig. 1; likewise, draw a line (EG) from the point E, which will be parallel to the line from A to C. EG and DF, intersect at point H. The stress on BC and AC of the rope is represented respectively by the distances DH and EH. Suppose it is found that the distances DH and EH measure three-quarters of an inch, then, as the scale is 1 inch = 50 lb., ¾ of an inch = ¾ of 50 lb. = 37.5 lb. on each part of the line, or 37.5 x 2 = 75.0 lb. total on the line.

By applying the same method of reasoning to Fig. 3 we see that the stress is increased because of there being less sag in the line, as shown by the increased distances of DH and EH in Fig. 4.

Now let us take another illustration, slightly different in application, but the same in principle as the other. In Fig. 5 is shown two rafters of a roof; at the apex a weight is placed. It makes no difference with regard to the principle

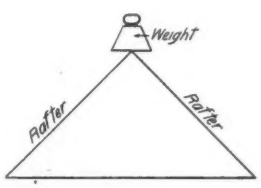


Fig. 5

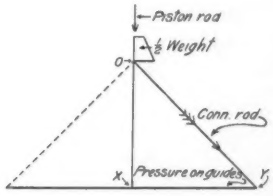


Fig. 6

involved just how much this weight may be. Each rafter will endure a stress greater than one-half of the weight, or both rafters will endure a greater stress than the weight of the weight, as has been shown in the first illustration. The more nearly vertical the rafters are, and the more acute the angle at the apex becomes, the less stress will the rafters have to endure. On the contrary, the more nearly horizontal the rafters become, and the more obtuse the angle at the apex becomes, the greater will the stress be.

Referring to Fig. 6, let us consider one rafter only, and that it is supported at the upper end by a vertical surface. As in Fig. 5, both rafters support the weight; in Fig. 6, one rafter will therefore support but one-half of the weight. Tersely speaking, we have cut Fig. 5 in half, vertically. The stress on the rafter is greater than half of the weight, because we have shown that the stress on the two rafters is greater than the weight of the whole weight, and so the stress on one rafter must be greater than one-half of the weight.

The application of the foregoing to the connecting rod of an engine may be made like this. Using Fig. 6 and turning it so that the bottom of the figure becomes the right-hand side when facing it, and the left-hand side of the figure becomes the bottom, the weight will represent the force acting through the piston rod, the line OX will represent the guide in which the cross-head runs, and the line OY will represent the connecting rod, connected to an imaginary crank at Y. Thus it may be seen that the thrust at the con necting rod is greater than the force acting through the piston rod, and that the amount of excess will depend upon the angularity of the rod.

It must not be inferred by the reader that because the thrust at the connecting rod is greater than that at the piston rod, that the work done by the connecting rod is more

than that done by the piston rod. Work is the product of force through space; and when the force acting through the piston rod for a given stroke of piston is considered in conjunction with the force or thrust acting through the connecting rod for a given horizontal and relative movement, it will be found that the products are equal, friction neglected.

A careful study of the foregoing should prove of value to the student of engineering.

EXPERIENCES WITH STEAM HEATING SYSTEMS

The Use of Exhaust Steam May Not Always Be the Most Economical

By Charles H. Taylor.

As the season requiring the use of steam heat approaches, most engineers prepare for it by endeavoring to get their plants into good condition, so that when it becomes necessary to use the steam for heating purposes they may obtain the best possible results under existing conditions.

The improvements in steam heating apparatus were never as numerous or as important as they are at the present day. Some systems are more elaborate and complicated than others, and the engineer, if he would be sucessful, should carefully consider the various methods. To suppose that one kind of apparatus, or a certain system will answer the purpose equally well under different conditions and various requirements is erroneous.

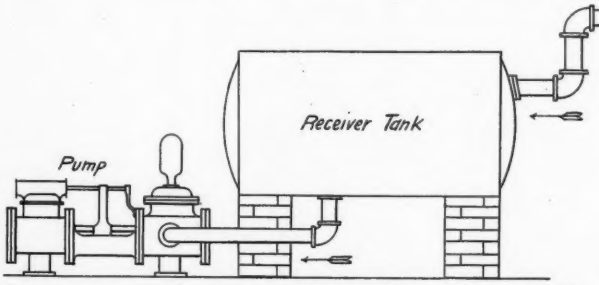
The construction and location of buildings requiring steam heat must be carefully taken into consideration if satisfactory results are to be obtained. Many modern factory buildings are constructed so as to keep out as much of the outside air as possible, except, of course, that which is required for ventilation, and whose admittance is specially provided for. On the other hand, there are buildings built without any regard to economy in heating, whose poor construction is evident by the numerous cracks and crevices through which the cold, outside air freely circulates. Such a building naturally wastes much heat, and therefore requires a greater amount of heat than the building which is properly constructed regarding heating economy. However, in a building built regardless of its heating economy, the amount of fuel consumed in heating should be of secondary consideration, because to heat such a building in a satisfactory manner, a greater amount of radiation, with a corresponding amount of boiler surface, must be used. The location of the building to be heated should also be taken into consideration. If the building is in a sheltered position, well protected from the wind, it will require less radiation and less boiler surface than if it occupied an exposed position. A good illustration of this may be seen in any of the apartment buildings which are becoming familiar sights in most of our large cities. Taking as an instance a three apartment flat, it is very apparent that the two apartments on either side of the building require much more radiation, with a correspondingly larger consumption of fuel, than the central apartment.

While the care and management of the heating apparatus and the economical consumption of fuel have much to do with the successful heating of a building, the main factors are the construction and location. The loss of heat caused from uncovered pipes is another factor that should be taken in consideration. To illustrate this point, suppose we have 150 feet of 3-inch pipe, carrying 90 pounds steam pressure, running through an atmosphere whose temperature is 40 degrees Fahrenheit. The outside diameter of a 3-inch pipe is approximately 3.5 inches, which multiplied by 3.1416 gives a circumference of 10.99 inches and the area of each foot in length will be 131.88 square inches. This area multiplied by the entire length, 150 feet, and divided by 144 (the number of square inches in one square foot) gives 138 square feet of condensing surface. The temperature of steam at 90 pounds pressure is 320 degrees and the difference in temperature between steam at 320 degrees and air at 40 degrees is 280 degrees. Therefore 138 square feet multiplied by 280 degrees, and the product divided by 420 gives 92 pounds of steam condensed per hour. With an evaporation of 7 pounds of water per pound of coal (some claim an evaporation of 10 pounds, but 7 pounds is nearer the average of the ordinary boiler) this would equal $92 \div 7$ or 13 pounds of coal per hour, 130 pounds a day of ten hours, and approximately half a ton a week. In this instance only 150 feet of pipe was taken in consideration, while in the majority of factories, where a much larger amount of pipe is in use, the saving would be correspondingly greater. Of course, the entire amount cited in the foregoing illustration could not be saved by merely covering the pipes, but a good pipe covering will reduce the condensation to a minimum.

A few years ago the writer, while traveling through the country visiting different plants and engineers, ran across quite a novel method of heating used by a manufacturing concern. The ceiling of the factory was supported by two rows of iron columns running down through the center of the factory at intervals of 15 feet. These columns were composed of 6-inch wrought iron pipe with flanges screwed on each end, and a blank was bolted to each flange with a gasket of wire gauze and red lead between the flange and blank. These columns were connected to a steam main at the top, and to a drip main at the bottom, which ran to a receiver and duplex pump rig by which the water of condensation was returned to the boiler. The radiation of heat from these columns was very great, keeping the factory quite warm in the coldest weather. Quite a saving in pipe was effected by this idea, as no radiators or heating coils were necessary. The columns did not take up any more room than the ordinary iron columns used for supporting, and did not in any way detract from the appearance of the room. This system was originally intended for the use of exhaust steam, but, owing to the back pressure needed to operate it, this was discarded and live steam

substituted, with the addition of the receiver and pump.

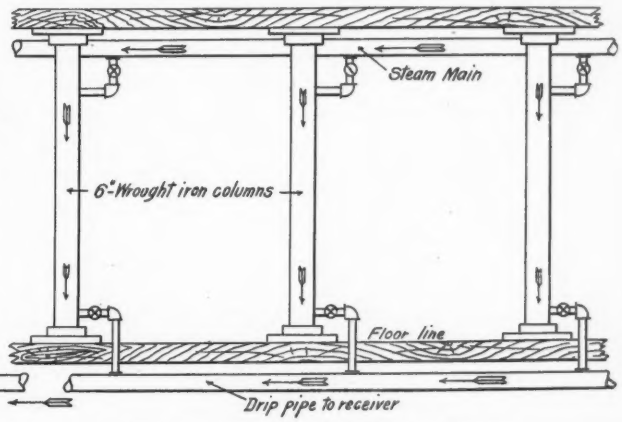
Sometimes the question arises as to which is the cheapest to use for heating, live or exhaust steam. In some cases it may be cheaper to use live steam, as when the exhaust is used to heat the feed water, while in other cases it might be cheaper to install a vacuum pump, to overcome any back-pressure on the engine, and use exhaust steam. To heat by exhaust steam without a vacuum pump necessarily creates back-pressure, owing to the fact that any condition of affairs that tends to retard the free discharge of the exhaust must cause back-pressure. As an illustration let us take a 12 x 18 engine, running 125 revolutions per minute. Now, assuming four-fifths of the stroke as the point where the exhaust valve closes in order to produce compression, we then have the piston traveling 125 x 2 1/3 feet, or 292 feet per minute. The area of a 12-in. piston is 113 square inches, which, multiplied by 292, gives 32,996 foot pounds of work per minute for each pound of back-pressure upon the engine. As 33,000 pounds lifted one foot high in one minute constitutes a horse-power, we are thus adding approximately one horse-power to the load of the engine. Now, considering the average rate of production of steam, and with an average evaporation of 7 pounds of water per pound of coal, and allowing 30 pounds of water per horse-power per hour, there will be a loss of 4½ pounds of coal per hour, or 45 pounds per day of 10 hours, for each pound



of back-pressure. Thus it is evident that in such a case the utilization of exhaust steam for heating purposes would not be economical.

The writer has seen instances where large weights and pieces of scrap iron were suspended from the lever on the back-pressure valve to hold it down. In these cases the cost of heating by exhaust steam must be far in excess of using live steam, especially so if the return is put back into the boiler, as by so doing a large saving of water is also made. If it is necessary to use the exhaust for heating purposes it would be better to use it in an exhaust injector rather than to maintain a back-pressure on the engine, as by using the exhaust in this manner a greater degree of heat is imparted to the water before entering the heater.

In the plant of which the writer now has charge, the feed water taken from the city mains is heated up to 140 degrees before entering the heater, and from the heater enters the boiler at 200 degrees. The water is forced into the boiler in a steady stream, without the pulsating action of the pumps, and the injectors can be set so as to give a constant feed all the time, thus keeping the water at a certain level. Some engineers object to this idea because of the liability of cylinder oil being carried into the boilers. The majority of good cylinder oils now on the market are the product of a mineral oil which is becoming recognized as beneficial in both removing and preventing the accumulation of scale in boilers. The writer has found out by his own experiments as well as by the experiments of others, that petroleum is a beneficial factor in the removal of nearly all kinds of scale, and that a small quantity of oil in a boiler is beneficial. Some engineers claim it makes the boiler foam, which is true if cheap oil or soap grease, which is about what cheap oil is composed of, is introduced into the boiler. If such an oil is used and the cylinder has to be slushed with it to accomplish the necessary lubrication, then it will find its way to the boiler and cause trouble. When such is the case, the engineer had better get a good



Peculiar Arrangement for Heating Factory

grade of oil and use less. Then, if by reason of using the exhaust for feed purposes a little more oil than is desired reaches the boiler, the installation of a separator in the exhaust pipe, leading to the injector, will remove all trouble.

In conclusion it appears to the writer that the using of exhaust steam in an exhaust injector in this manner is much more preferable to using exhaust steam for heating, as the water is not only put in by a power that would otherwise be wasted, but a large portion of this same power is condensed and returned to the boiler.

The Use of Mica, One of the Most Valuable Insulating Materials Used in the Electrical Industry, Rapidly Increasing.

The properties which give mica its value to the world of industry are its perfect cleavage, the toughness, flexibility, and elasticity of its cleavage sheets, and its transparency and non-conductivity of electricity. The three principal uses of the material are for electrical insulation, glazing and decoration. The first named use probably leads in present importance, but the other two uses date back to ancient times, mica antedating glass and also being early used to secure decorative effects. As an insulating material, it occupies a place that cannot be filled by any other substance. Recently the utilization of scrap and waste mica in the manufacture of lubricants for car axles has become a somewhat important industry in the West.

The increasing use of the material has largely modified the demand made upon the mining industry, for not only can sheet mica of small size now be utilized, but even more

important is the extensive use that is now made of composite mica, molded mica, "micanite," and other varieties of built-up sheets. Scrap mica is also utilized in the manufacture of a superior quality of boiler lagging, and ground mica is used in somewhat increased quantities in mica bronzes and paints, and as an absorbent for explosives. The finest ground mica, or mica flour, finds a considerable market with manufacturers of high-grade wall papers, the luster obtained by the use of muscovite dust having the advantage of both permanency and brilliancy.

The total production and consumption of sheet mica in the United States in 1906 was 4,489,838 pounds, as against 2,519,445 pounds in 1905, an increase of about 78 per cent. Deposits carrying mica in commercial size are found in many parts of the United States from the Atlantic coast to the Pacific, and new developments are reported each year.

Tempering Springs.

There is perhaps no kind of tempering that requires so much care in manipulation as getting a good spring temper. It is necessary that the spring be carefully forged; not over-heated and not hammered too cold, as the one is as detrimental as the other. To insure a spring that will not warp in tempering, both sides must be hammered, for if it is not, the metal will compress more on one side than another and permit the spring to warp or twist.

After the spring is forged and finished up it is ready for tempering. Clean out forge and have a brisk fire using good clean charcoal. If bituminous coal is used it must be well burned to a coke so as to free it from the sulphur, which will destroy the "life" of the spring. Place spring in fire and heat very slowly and evenly throughout its entire length and through its thickness. When a light red in color plunge evenly into luke-warm water, so as not to chill the surface of the metal too quickly before the inside can harden. Allow the spring to lie in the water until it is the same temperature as the water. Animal oil (whale or lard oil) is better than water, as the oil does not chill the metal as quickly as water and is therefore less liable to crack it. Lard may be used by melting it first before plunging the spring in.

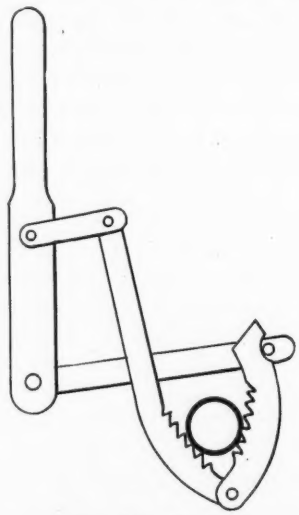
Take the spring out of the water or oil after being cooled and prepare to temper. Have a brisk fire with lots of live coals, and smear tallow over the spring. During this operation do not increase the draught with the bellows, but let the fire heat the spring very slowly. If the spring is long, move slowly over the fire so as to heat equally. The tallow will meet and then blaze for some time, and while blazing incline spring, or elevate either end that the blaze may circulate through the spring and envelope it from end to end. When blaze dies out smear again with tallow and proceed as before. If the spring is to stand a great strain or perform much work it will be well to blaze off lightly a third time.

Spiral springs, such as used in spring balances, indicators, etc., are tempered by being heated in a closed pan with animal charcoal or bone dust packed around them, and when thoroughly heated are cooled in an oil bath. The tempering is accomplished by putting a handful of them in a sheet-iron pan with tallow or oil, and the pan kept constantly moving over a brisk fire. The tallow soon blazes and the moving causes them to heat evenly. Springs that are tempered in this manner may literally said to be "fried in oil."

A long and slender spring, requiring only a low temper, may be tempered by beating the soft forging on a smooth anvil with a "smooth-face" hammer. By this means the metal will be sufficiently compressed to form a good spring without any further tempering. A light hammer should be used and many blows struck. Such a spring should last for quite a while, providing it does not have to withstand any great strain in its action.

A New Pipe Wrench.

Inventors have studied and worked over the problem of devising a satisfactory pipe wrench for many years. Hundreds have been patented, but few have been practical in use. A great many have been too complicated, making the cost of manufacture prohibitive. A Wisconsin man has devised the one shown here, which has the merits both of



A New Pipe Wrench

simplicity and practicability. By referring to the illustration the method of operation will be apparent. The jaws of the wrench are placed around the pipe, the free end of the lower jaw being pivoted to the handle, which serves as a lever. The greater the pressure on the handle, the tighter will the jaws grasp the pipe. When the pressure has become sufficient to rigidly hold the pipe, the latter will then be forced to follow the direction the handle is traveling. In addition, no time is lost in obtaining a fresh grip on the pipe for the next turn.

High Speed Tool Steels.

By George E. Walsh.

The modern high speeding of tools either by electric or belt power has greatly increased the output of the machine shop and saved enormously in different manufacturing and producing lines; but the question of hardening new steels to meet the requirements of the changed conditions has really been the hardest to solve. Until manufacturers of steel could produce tools with a cutting edge sufficiently tough and elastic to

withstand the severe strain, high speeding was impracticable. The introduction and improvement of the new steel for cutting tools have been interesting. The difference between the ordinary high carbon steels and the new high speed tool steels represents the difference between profit and loss.

On mild steel forgings, the old carbon steel tools could rarely exceed a cutting speed of 25 to 30 feet per minute, but the same forgings to-day are cut at a speed varying from 80 to 90 feet per minute. The saving in the shop effected by the high speed tools is chiefly in the roughing department, and not so much in the finishing. According to the estimates made in the average shop the roughing of forgings and other metals represents about 40 per cent. of the total work of manufacturing. On an average the use of modern high speed tools saves about 60 per cent. of the time of roughing. The total saving through the use of the improved high speed cutting tools is thus about 60 per cent. of 40 per cent., or 24 per cent. of the whole output.

Shops doing light finishing work cannot effect as much of a saving as those which produce heavy, roughing work. The improvement in the cutting tools for finishing work is, however, developing rapidly, and with the electric drive the advantage gained in the roughing department is gradually extending to the finishing department. The ordinary high-speed tool in the roughing department does not actually cut by means of a sharp edge, but it acts more as a wedge to tear and wear off the shavings. In the finishing department the tools run at a high speed cannot retain for long a fine edge necessary to do the work properly. It is to secure better results in this respect that manufacturers are steadily experimenting in hardening the edge of steel tools.

In the machine shop there has been going on a steady competition between the tool steels and the machine tools very much like the struggle for supremacy between armor plate for warships and the projectiles manufactured to penetrate it. The improvement of either one necessitates a similar improvement in the other. Heavy forgings and tougher steel to be cut imposed a strain upon the old machines until a limit was reached. The work was slow with the old form of engine lathe and diamond-pointed type of cutting tools. To increase the output of the shop more machines had to be installed, and in such a way that a single operator could control several. This system did not work satisfactorily, for the maximum amount of work could not be secured from each machine. To-day the tendency is to secure from each machine all the work possible, and the result is that there is a steady improvement made in the tool steel and in the machine tool design.

The Bethlehem Steel Company was one of the first to start a series of expensive experiments to secure tough tool steel of a uniform grade for high-speed machines. In the series of tests made more than 200 tons of steel billets were cut up into chips to ascertain the relative cutting value of different grades of steel, and also to study the peculiar action of the cutting edge when wedged against the forgings.

A great variety of special alloy steels hardened by different methods were employed. The results of these and other tests by different concerns have been of great practical value, but no absolute law has been established for manufacturing tool steels that will produce always the highest results. Manufacturers differ in regard to the chemical composition of the steels. The Bethlehem works used steel containing certain percentages of chromium and tungsten of molybdemum, while others have, besides the ordinary elements in their steel, certain percentages of tungsten, chromium and molybdemum put in and then subsequently removed by secret processes. Whatever the composition of the different tool steel may be, the fact that it will stand the strain of ordinary high-speed machines suffices.

Before it was possible to speed tool machines, work in the average machine shop was generally far behind the forge shop, and in some plants this difference was so great that the forge shops had to shut down or run on part time at intervals. It seemed impossible to equalize methods without enlarging the machine shops would have to be doubled in capacity to keep new plans for plants showed that in the future the forge shop would be made much smaller in size and output relative to the machine shop. In the old plants it looked very much as if the machine shops would have to be doubled in capacity to keep pace with the forge shops then existing.

The new tool steel suitable for the high-speed machines brought relief and completely changed conditions. With the new high-speed roughing machines installed, the block from the forge shops was cleared up, and an increased output of the latter was met with equal success. The effect of this was tremendous, and the saving obtained in the past few years as a result of much larger output has given manufacturers better opportunities to compete with foreigners in distant markets. There has probably been nothing within modern times that has more generously helped to turn the scale in favor of American manufacturers than this introduction of high-speed cutting and roughing machines in shops and factories.

The advance naturally has been gradual, and the present high-speed tool cutting machines are still changing to meet the requirements of the day. The early ones were far from being what they are to-day. The air-hardened steel could only be made into a few tools, and these were not at first suitable for finishing cuts or for work upon cast iron. Neither could the steel be made successfully into reamers, milling cutters and taps.

But a wider field for improvement has been opened recently with steel tool that can be machined into almost any desired form of cutter, and then hardened in oil. The gradual improvement of the tool has made it possible to turn out machines that will cut and finish cast iron with comparative ease. The work has divided itself up into two distinct departments—tools for roughing and for finishing. The former are made of the best steel composition by secret processes and in the form of dutch-nose edges, but the finishing tools are made of the high carbon steels. The latter possess a fine close grain, which gives them a fine cutting edge to produce a smooth surface.

The manufacture of steel for high-speed cutting has naturally encouraged the development of the machines themselves, and manufacturers are bringing out machines that will apparently meet all the requirements of the trade. The machines are larger, heavier and stiffer, and lathes, for instance, intended for very heavy rough work are built on solid foundations instead of legs. All the bearings are larger and stiffer, while the steel that enters into their construction is made as tough and strong as modern scientific methods can do. The proper setting of the tools has also been changed, so that there is little loss of time in resetting tools. This alone has effected an improvement that saves many dollars a year to the shop.

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CONTENTS

A New Direct Acting Solar Engine..... 3
Engineering in a Nutshell..... 5
Value of Large Steel Castings in Electrical Construction 7
Packed Joints 7
Heat, Light and Power Plant at Lockport, N. Y..... 8
The Inertia Governor 10
A Talk with a Chief Engineer—Talk No. 4..... 13
Large Copper Pipes 14
Thrust of a Connecting Rod 15
Experiences with Steam Heating Systems..... 16
The Use of Mica Rapidly Increasing..... 17
Tempering Springs 18
A New Pipe Wrench 18
High Speed Tool Steels 18
Editorials 20-21
Letters from Engineers:
J. E. M.'s Condenser Arrangement not Economical.. 22
Increased Compression Better than Reduced Vacuum 22
T. S.'s Condenser Arrangement Will not Use More Steam 22
That Clicking Noise in Cylinder 22
Sanding a Large Commutator 23
Data About Water and Steam for Practical Men.... 23
Convenient Method for Centering Hub on Shaft..... 24
Experiences in a Central Station 24
Feed Water Regulators 25
Handy Gas Engine Tools 25
Is it Cheaper to Buy New Machinery or Employ Good Engineers 26
Engineering Books Good to Him 26
Lever Safety Valves 27
A Durable Whitewash 27
Questions and Answers 28-29
New Power Plant Equipment.....30-33

Engineering Design

The disaster at Quebec, in which many persons lost their lives when a portion of the bridge, which was being built over the St. Lawrence, collapsed, calls attention to the fact that the laws of science must command respect, and if they are violated, the inevitable result must happen. Unfortunately, it is the tendency of modern times to lay aside precedent and to become reckless toward those things which are governed by unchangeable laws, but fortunately this tendency has not developed very far in the engineering field, because the engineer knows only too well that the laws of nature are fixed and immutable.

This tendency of recklessness is sometimes shown when cold water is put into a red hot boiler or when a cold reciprocating engine is started without warming up, but in these cases the man who does the reckless act generally is punished by the results which follow. It is when recklessness takes place in the design of structures and machinery that the direst results happen because they are usually of such a subtle nature that they cannot be detected before the accident happens.

In the Quebec disaster it has been clearly shown that the chord of the bridge which failed and which caused the bridge to collapse was due to improper design and not to the fault of the materials or construction; but since the Quebec bridge was one of the largest ever built, it is said that there was no precedent by means of which the proper strain could be determined on the bridge members. A number of concrete buildings, from one cause or another, have collapsed while being built, which was caused, it is claimed, by improper and reckless construction rather than faulty design.

This defect in the design of structures and machinery directly affects the engineer, because, when anything unforeseen happens, the blame will usually fall on him, as he is the man on the job. Designing engineers cannot be too careful in selecting the proper design and materials which go to make up a piece of machinery, and precedent, which is the result of experience, must, as far as possible, be the guiding rule in figuring the strains and stresses on any given part.

The Quebec bridge disaster has caused a great sensation in engineering circles and has given fresh impetus to the study of the chemical properties and strength of steel, which will probably result in designing engineers being more careful in taking chances in the future.

—o—

A Position; An Applicant; An Examination.

As we have had occasion to mention before, the fact that an engineer does or does not pass a theoretical examination is no indication as to whether he is fitted to take charge of a large power plant. A man may understand all the various principles of thermodynamics, and be acquainted with adiabatics and isothermals; he may understand the value of the fourth dimension; he may know just how much potential it takes to make lightning jump from one cloud to another; he may be able to figure out all the reasons why an alternating current does not follow the sine curves; he may be able to calculate accurately the amount of steam that is leaking around a pipe joint; he may know, theoretically, how to extract every drop of sweat from a poor heat unit, and make it do

some share of the 33,000 foot pounds of work that we are all striving for—but, he may not be an engineer. If a drop of hot water from the leaky pipe joint fell down such a man's neck it is probable that he would have to retire for repairs, and if a few of those heat units happened to be floating around the engine room on a warm day it would mean that he would exert more foot pounds of energy to get away from them than he ever could figure out for them on paper.

We do not in the least wish to cast any reflections on the high-collar, boiled-shirt, mahogany-desk engineer, but we claim that it is not necessary for a man to wear a high collar or sit behind a mahogany desk to be able to get the best results and economical operation out of a plant.

When one of the requirements for the position of chief engineer of the Chicago post office was changed so that others who were not technical school graduates could participate in the examinations, due to the heavy pressure brought to bear upon the United States authorities by different engineering associations, the thought immediately occurred to us, and we so voiced it in these columns that all that it was necessary to do was to ask a lot of theoretical high-falutin questions and the chance of a practical man getting the job was all off. The examination was held the last three days of August, and if any man could for seven hours on one day, seven hours the second day and five hours the third day, answer all the questions that were given him, then our idea of the limits of human brain power and endurance are all wrong. The questions involved the subjects of Mechanisms and Applied Mechanics, Thermo-dynamics, General Engineering and Electrical Engineering, and ranged all the way from the method of laying out a set of bevel gears and the description of the action of the velocity of efflux of an efflux tube to the complete description of a modern mechanically and electrically equipped building. Jammed in the three days were questions involving definitions, differences, comparisons, calculations, designs, specifications, descriptions, chemical analysis, testing, drawing, sketching, formulae, and many other things which takes a man a lifetime to find out, but only a few days to forget, and certainly more than nineteen hours to draw, write and calculate.

This reminds us of the engineer who was fifty years old, and who applied for the position of chief in a very large plant in which all the various phases of power plant design and equipment were represented. After the superintendent has quizzed the applicant for several hours as to his ability to handle turbines, reciprocating engines, air pumps, condensers, different types of mechanical stokers, economizers, water-tube boilers, types of generators, etc., he asked the applicant his age. When the superintendent heard that he was fifty he shook his head and said that even though he was satisfactory in all the other requirements, his age was against him, as they required a young man not more than thirty-five years of age. The engineer indignantly retired with the remark that he hoped that they could get a young man of thirty-five with the knowledge which it took him thirty-five years to accumulate. The result was that the young man whom they did get ruined three times the value of his salary in machinery the first three weeks he was on the job.

What the Civil Service Commissioners want is not a chief engineer at Chicago, with a modest salary, but a human prodigy—one who knows the principles of engineering from A to Z, one who can finesse the English language so that he can give definitions that mean nothing; one who can toy with figures in their various applications; one who can make drawings, draw specifications and design machinery; or, in other words, they want—but what's the use; the examination was opened to all and as a result everyone seems satisfied.

Care of Lightning Arresters.

Lightning arresters should be connected to the feeder lines by copper ribbon, not wire, as the former has much less self-induction. This should be run as directly as possible, avoiding sharp bends and particularly anything in the nature of a coil. The arrester should be placed in a convenient position for inspection and cleaning.

During the season of thunder-storms, the arresters should receive proper attention, so that there will be no chance of the discharge points becoming burned or blistered.

Too much stress cannot be laid upon the necessity of making good ground connections. Ground plates too small in size covered with a heavy coating of rust, or immediately surrounded by dry soil, will prevent the best designed arrester from saving the station apparatus in case of lightning discharges.

A good ground may be made by sinking a copper plate three or four feet square in soil continually wet. A layer of coke around the plate is desirable. Copper is preferable to iron on account of corrosion and rusting of the latter. It is much easier to make a first-class connection to a copper plate, this being absolutely essential. The conductor through the earth should be of ample size to prevent its being eaten off by corrosion. In adition to this it is advisable to connect, if possible, to a water pipe running under ground, the pipe being thoroughly scraped at the connection.

Causes of Boiler Explosions.

The results of some experiments for determining the conditions under which boilers burst were recently published in *Stein und Eisen*, a German scientific periodical. For measuring the temperature of a boiler plate, with various intensities of firing and under different circumstances, a plate 10 millimeters, or about 3/8 of an inch thick, received a layer of water inside, while the outside was subjected to the action of a blow-pipe flame, the quantity of heat traversing the plate being measured by the volume of cold water vaporized, and the outside temperature of the plate by metal plugs fusible at various temperatures.

The experiments showed that, when the plate is sound, clean and thoroughly wetted by water, it never attains a dangerous temperature, even with the hardest firing, and that viscosity of the water exerts but little influence; but, on the other hand, the deposit of scale, even in a very thin layer, may lead to serious accidents. Some fatty matters coating the inside surface of the plate readily cause it to become red-hot, even when in contact with water, which in that case assumes the spheroidal state, this being the case with organic fatty matters, especially linseed oil and red lead cement.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

J. E. M.'s Condenser Arrangement Not Economical.

EDITOR THE PRACTICAL ENGINEER:

Mr. J. E. M. in the October number gives a design of condenser and wants to know what the readers think of it. Although the design is rather ingenious, there are points about it that are not consistent with condensers. In the first place, the condenser is open to atmospheric pressure, and if the engine is operating with a back pressure above atmospheric pressure, the back pressure will be reduced to atmospheric pressure, but no further. If the engine is exhausting at the pressure of the atmosphere, no economy could be gained by such a device.

In considering the economy to be gained there are several features which must be taken into consideration. If the back pressure is reduced the temperature of the water entering the boiler will be reduced. This will cause a reduction of economy in the boiler room. There is also the steam consumed by the pump, together with the cost of repairs and upkeep of the pump to be considered. The loss due to reduced temperature added to the cost of pump repairs and up-keep must be subtracted from the gain due to reduced back pressure to get the net saving.

I doubt if the net saving from an arrangement of this kind would be enough to pay interest charges or to cover the first cost of installation, let alone depreciation and repairs.

F. W. C.

New Bedford, Mass.

Increased Compression, Rather Than Reduced Vacuum, Will Prevent Pounding and Give Better Economy.

EDITOR THE PRACTICAL ENGINEER:

In reference to C. N. L.'s questions as to why reducing the vacuum stops pounding, I would say that I think this is a very uneconomical method of producing the desired result. What is needed in his case is more compression, and that is what he gets by decreasing the vacuum. By decreasing the vacuum the point of exhaust closure is higher, which gives a higher compression and consequently a quiet running engine.

The proper way to get higher compression is to make the time of exhaust closure earlier, either by advancing the eccentric, if two are used, or by putting more lap on the valve. Reducing the vacuum means reducing the economy, and that is bad practice.

If C. N. L. will use his scale rule and measure the compression pressure on both sets of cards he will see my point very clearly. If the engine pounds as badly as he says it does, the rise and fall in the pressure line of the indicator card is caused by the vibration set up in the indicator as each stroke is completed.

F. W. C.

New Bedford, Mass.

Reasons Why T. S.'s Condenser Arrangement Will Not Use Any More Steam.

EDITOR THE PRACTICAL ENGINEER:

In the September number of THE PRACTICAL ENGINEER I notice T. S., Pittsfield, Mass., asks for more definite information on his vacuum pump problem. As I cannot find the June number, in which his original question appeared, we will answer the question as it appears in the September number. "Will the condenser pump use more steam when lifting water 12 ft. than when the water runs to the pump?" Now, if the question ends here and nothing more is assumed, it would be very easy to settle the question, for surely T. S., his chief, and all the other first-class engineers, know that it would require more power for one of them to climb up twelve steps of a stairway than it would to stand on the floor; thus it appears T. S. is defeated; but hold on a minute, boys; don't run away laughing—T. S. has the last laugh—for as we read further on in his letter we can see that instead of having a stationary stairway he has a modern *moving* stairway (25 inches of vacuum), so any of you can go up the amount of twelve steps without expending any more power than if you remained on the floor.

Ah! ha! T. S. is smiling, but his chief does not seem to be satisfied with this "horse reasoning"—he wants the theory of it worked out in figures. All right, T. S., you get another chance to laugh. Mr. Chief, when you form one inch of vacuum with your vacuum pump, that one inch of vacuum will cause the water to raise in the suction pipe 1.133 ft. Now, if you form a vacuum of 25 inches and maintain that vacuum, you cannot only cause the water to be raised 12 ft. in the suction pipe, but $25 \times 1.133 = 28.325$ ft.; so you see you have 16.325 ft. to spare.

Thus it is evident that the condenser pump in this case will not use any more steam when causing the water to be raised 28 ft. than it would when the water flows to it.

J. W. B.

Mt. Kisco, N. Y.

That Clicking Noise In the Cylinder.

EDITOR THE PRACTICAL ENGINEER:

Not very long ago I had charge of a steam plant in a large office building in which there were two 150 horse-power Ames engines, which took the lighting and elevator load during the day, and a McEwen engine, which furnished light through the building for the scrub force, when the Ames engines were shut down.

It was the McEwen engine that gave me the trouble. These engines are fitted with marine-ended connecting rods, and therefore, by taking up on the crank-pin boxes, the piston will be drawn toward the crank-end of the cylinder. I noticed that every time I took up the wear on the crank-pin boxes there would be a sharp clicking noise at the crank-end, and as the engine was making 275 revolutions per minute, the sound was very disagreeable, and the fact that the superintendent's office was not far away made matters worse.

After the engine would run for a couple of hours, the clicking noise would decrease, and that is what kept me guessing. I could not understand why the noise should cease, if the piston was striking the head of the cylinder, so I started in to locate the trouble. The next evening, between five and six, I put on the indicator, and I cut out one of the Ames engines so that it would have a good load. I took several cards, but there was nothing that showed that the compression curve was wrong or that the clearance had been reduced any appreciable amount. The next thing to do was to take out the piston, which we did at the first opportunity, and then we saw the trouble good and plain.

The ring nearest the counter-bore had a very bad scar on it, which showed that it had been coming in contact with the nipple of the indicator connection. The man who put the nipple in there must have forgotten that the rings had to travel over the edge of the bore of the cylinder, and if such pipes are screwed in too far, trouble will follow.

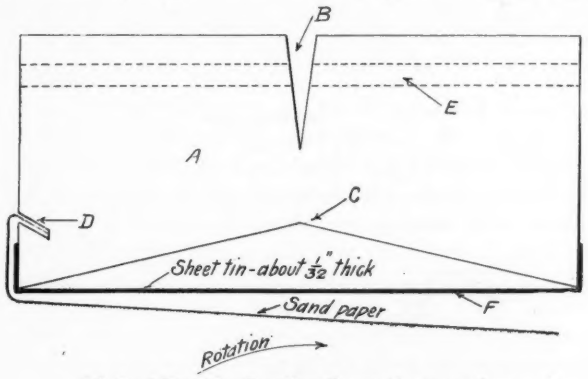
The old nipple was taken out and replaced with one with a shorter thread, and tne clicking noise was a thing of the past.

Roxbury, Mass. W. D.

Sanding a Large Commutator.

EDITOR THE PRACTICAL ENGINEER:

An article entitled "Sanding a Large Commutator," which appeared in the September issue of The Practical Engineer, prompted me to send in the following. The idea is not orignal with me, as I got it from others, but I have found it so good that I wish to pass it along, trusting



Method Used for Sanding Large Commutators

that others may also benefit by it.

The accompanying sketch is that of a block for sanding large commutators, the use of which does not require that the true curvature of the commutator be known. As shown in sketch, A is a tough, close-grained block of wood 6" x 3" x 3". At B is shown a V-shaped slot cut half way into the block, and at C a long V-shaped section is cut away. D is a saw cut running the width of the block, E a hole for a ½" bolt, and F is a piece of sheet tin, or galvanized iron.

After nailing the sheet tin to the block, pass a bolt through E and tighten up until the tin is stretched tight. Slip a piece of sandpaper into cut D, as shown in illustration, and then lay block on surface of commutator with direction of rotation as indicated in sketch. Cut the necessary tension on block, and the tin and sandpaper will assume the shape of the commutator, which will be smooth and nicely polished.

The latest method, and perhaps the best, for sanding commutators is to use a soft green grit, or sandstone, which soon takes the shape of the commutator and has a better effect on the mica insulation between the bars, cutting it down with the copper, which sandpaper does not always do.

Fairport Harbor, Ohio. E. S. H.

Data About Water and Steam for Practical Men.

EDITOR THE PRACTICAL ENGINEER:

As most data that is printed is given so that a man with a common school education cannot understand it, I will try to give a few facts and figures about water and steam that can be understood by everyone.

Doubling the size of a pipe increases its capacity four times.

Friction of liquid in a pipe increases as the square of the velocity.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column of water in feet by .434. Some figure one-half pound for every foot elevation, which is accurate enough for rough calculation and makes allowance for friction.

To find the horse-power necessary to elevate water a given height, multiply the weight of water elevated per minute in pounds by the height in feet and divide by 33,000. Allow 20 to 30 per cent. for friction loss.

The area of a steam pump piston multiplied by the pressure per square inch gives the total pressure exerted. The area of the water piston multiplied by the water pressure per square inch gives the amount of resistance. A margin of from 20 to 40 per cent. must be left between the pressure exerted and the resistance depending on the speed and condition of the pump and piston rings.

To find the capacity of the cylinder in gallons, multiply the area in square inches by the length in inches and divide by 231.

My experience with various pumps shows the following comparative cost of pumping: A triplex power pump connected to steam engine requires 5 pounds of coal per horse-power hour; when connected to gasoline engine, 1 pint of gasoline per horse-power per hour, when connected to a gas engine, from 15 to 20 cubic feet of gas per horse-power hour, and when connected to an electric motor it requires 3 cents per horse-power hour if the current can be generated or obtained for 4 cents per kilowatt hour. A duplex pump will consume 20 pounds of coal per horse-power hour. Some large pumps use 13 pounds of coal per horse-power hour and injectors about 75 to 100 pounds, although the heat of the latter is given up to the feed water.

Under the ordinary atmospheric pressure of 14.7 pounds per square inch, water boils at 212 degrees Fahr, the temperature of the boiling increasing as the pressure increases. Steam is transparent and invisible except when partially condensed, when the mist makes it visible. Dry steam is steam not containing any moisture and is transparent. It may be either saturated or superheated. Steam is saturated when in its normal state; that is, when it is at a temperature due to its pressure and when it is in proximity

to the water from which it was generated. Superheated steam is higher in temperature than the water from which it was generated. Wet steam contains water in the form of a spray, but is at the same temperature as dry steam of the same pressure.

One cubic inch of water evaporated in steam at 212 degrees will occupy 1646 cubic inches. It is sometimes stated roughly as one cubic foot. At atmospheric pressure, 26.36 cubic feet of steam will weigh one pound.

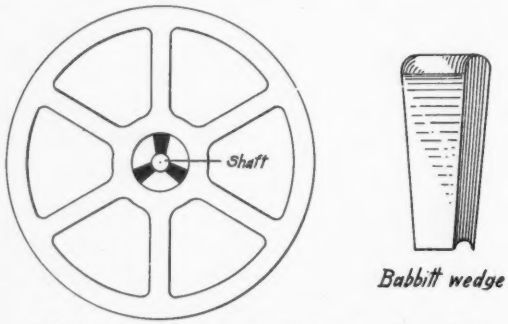
Orange, N. J. S. J. K.

Convenient Method for Centering Hub on Shaft.

EDITOR THE PRACTICAL ENGINEER:

The following is a description of a simple and convenient method for centering and truing up a large hub on a small shaft, which I trust may prove helpful to some of the readers of THE PRACTICAL ENGINEER:

When it is necessary to babbitt a large hub of a wheel or gear on a small shaft, make six babbitt wedges about one-half inch thick, with the width in proportion to the size of



Method of Centering and Truing up a Large Hub on a Small Shaft

the hub, and the length of the wedge. These wedges may be made by pouring babbitt in a wedge-shaped groove cut in a board, or they may be moulded in sand and smoothed up with a file. Place three of these wedges on each side of the hub, as shown in illustration, and by driving the wedges in or out the shaft may be correctly centred and trued with the wheel. After finding the proper position, secure shaft and wheel by blocking and arrange the putty or clay for holding the babbitt, and as the hot babbitt is poured the wedges will melt and leave a solid true box.

North Bend, Neb. G. G. M.

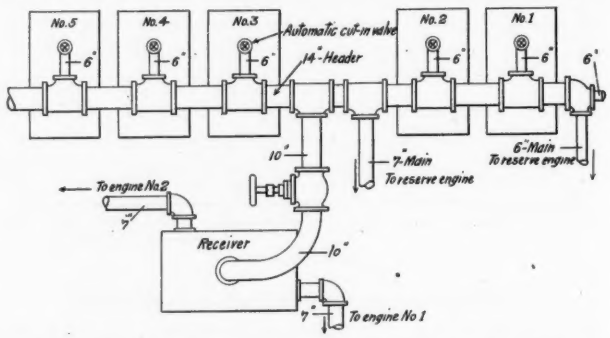
Experiences in a Central Station.

EDITOR THE PRACTICAL ENGINEER:

I was running a 20-in. x 36-in. x 42-in. cross-compound Corliss engine in a paper mill. This engine runs 24 hours per day, but nothing ever happens. All I had to do was to watch the wheel go round and read your paper, but as I am a young man I thought I would get a job where I would be called upon to work my hands and brains; so I got a job in a street railway power house, and in the few months I have been there I have seen more things happen than in all the rest of my experience.

There are five horizontal tubular boilers in this plant carrying 140 pounds pressure with a system of piping as shown in sketch. There are two 18-in. x 30-in. x 36-in. vertical Corliss engines, direct connected to direct-current generators, running at 135 revolutions per minute, and two horizontal reserve engines. The first day I was on duty I noticed a peculiar pound in No. 2 engine as the piston reached the top or head-end centre, so I cut it out and shut down after getting one of the reserve engines on the line. After investigating I found the babbitt in one of the cross-head shoes broken in several pieces. We repaired it, but within several days No. 1 engine gave out at the same place, the cause being too much lost motion between the shoe and the guide. While No. 1 was being repaired, I took a walk around the reserve engine we were running, and I found the low-pressure wrist-pin nut on the floor and the pin almost out. The engine was stopped in a hurry and the pin replaced. On another night I noticed the rheostat of No. 1 machine on fire, so I shifted the handle to a different position, which stopped it, but fearing something serious had happened, and as my electric knowledge was limited, I sent for the chief, who investigated and found one of the leafs grounded. He cut it out and everything went O. K.

We have a water front around the furnace doors of the boilers, but there are no valves between the water front and the boiler. The other day one gave out and it did not take long to empty that boiler. I cut her out, but did not have to pull the fire, opening the furnace doors to cool it off. The fireman said he could not keep up steam with the boilers, and the steam was going down fast, although the load was light. I took a look at the fires and found they were black, with no draft, and then I wanted to kick myself, as I had forgotten to close the hand damper on the sick boiler. After I had closed it the steam came up all



Why does Boiler No. 3 Use more Water than the other Boilers?

right, so I broke the connections to the water front and plugged them, filled the boiler with water, raised steam to the normal pressure, but the automatic cut-in valve failed to open. These valves can be shut by hand, but they cannot be opened with anything except an equal pressure on both sides. I found that the chamber in them had to be filled with a special oil and then they gave no trouble.

The motor that runs our scraper went out of business one day, so the chief took it down and repaired it, then ordered me to put it back in its place and connect it. I did so, but when it started it would run for a little while and throw its belt off. I crossed the belt and ran the scraper the other way, after which it ran all right.

At another time I noticed water coming out of the exhaust pipe in a good-sized stream. We were repairing one of the condensers at the time; so one of the engines was running non-condensing. I threw the load off the engine and went to the boiler room and found No. 3 boiler showing no water in the glass and the steam down to 80 pounds. I ordered the fireman to bank the fire and cool her off. After a while we got it in line again, but as the load when on the steam came down again to 80 pounds, and No. 3 lost its water again. I knew that if the steam got below 80 pounds the engines would pump the boilers dry, but why should they pump No. 3 dry and not the others, is what I cannot see. Is it because the engine pipe is closer to it than to the others? I would like to hear from other engineers about this, as some of them must have had a similar experience.

I changed my job to get more work, and you bet I am getting it and learning a lot besides.

Pittsfield, Mass. T. S.

Feed Water Regulators.

EDITOR THE PRACTICAL ENGINEER:

Automatic appliances for the regulation of feed water for steam boilers are a move in the right direction, as a general rule, but there may be exceptions to it as follows: A few months ago the superintendent of a large building in which steam heat and power are supplied to various tenants, stated that he was thinking of installing feed water regulators on his boilers. When he asked for my opinion on the subject I advised him not to do it. Of course there was a good reason for this advice, which is contrary to what would be given in many other cases, and an explanation will prove interesting, as an important principle is involved.

This is one of those poorly managed places where the engineer is kept out of his engine room as much as possible, for the purpose of doing other work, some of which ought to be done by suitable mechanics employed by outside parties, and the remainder by laborers as required from time to time. The fireman is expected to do some of the work that properly belongs to the engineer, the result of which is unsatisfactory in many ways.

The superintendent claimed that if he could induce the owner to equip the boilers with these regulators he could make the fireman do other work about the premises, as he would not have to spend so much time watching his water level, and by adopting this plan he expected to save enough on the fireman's labor to pay for the regulators.

This kind of management is wholly wrong, because it requires both engineer and fireman to be absent from their proper places. Although the fires may last until they return, and the regulators will keep the boilers supplied with water, and although the engine is almost sure to run without accident, there is too much chance for something to happen that is not on the program.

If appliances can be adopted that will save enough fuel to pay for themselves in a reasonable time, they should be unstalled without delay, as such action results in less labor for the fireman in shoveling coal and ashes, giving him more time to spend in keeping his boiler fronts and fixtures, also his pumps and other appliances clean and in good order, but when the main object is to form an excuse for sending the fireman to other parts of the premises, the line should be sharply drawn at this point.

As this subject interests many readers of this paper, I hope to read their opinions in future issues, as such discussion is profitable to all concerned.

W. H. WAKEMAN.

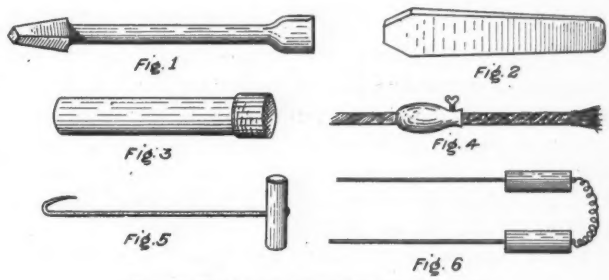
New Haven, Conn.

Handy Gas Engine Tools.

EDITOR THE PRACTICAL ENGINEER:

The following is a description of several handy gas engine tools, which may be easily and cheaply made and will prove of timely assistance to anyone operating a gas engine.

As shown in the illustration, Fig. 1 is a valve seating tool which can be placed in a brace and used for regrinding a valve, which operation can only be accomplished by reaching through a hole in the cylinder, It can be made of any old piece of steel and should be about 14 or 16 inches long. Fig. 2 is a slightly tapered wedge used for prying off the cylinder head and other parts of the gas engine. It is made from an old carriage or wagon spring leaf, and sharpened at one end for scraping off old asbestos packing. Fig. 3



Handy Tools for Gas Engine Repairs

is a lead punch used in marking and cutting the paper packing while the packing is being fitted to the cylinder head. It is also useful for driving valves in place without battering or injuring them. The punch is of lead and may be moulded in a hole, bored in a block of wood. On one end of the lead is driven a brass or iron ferrule. Fig. 4 is a piece of steel rope with a wooden handle, which slides over the rope, and which may be clamped at any place by the small thumb screw. The rope should be about eight or ten feet long and one-quarter inch in diameter. One end is tied with a fine wire about two inches from the end leaving the sharp steel wires of the rope to act as a brush. It is used for inserting in the gasoline or other pipes and removing any sediment or obstruction from them. Fig. 5 is a piece of steel wire bent in the form of a hook and fastened to a wood handle. It is used on several different makes of engines for catching and lifting the spring out of the gasoline chamber. Fig. 6 is used for testing for short circuits around the engine when it is necessary to reach in difficult places while the engine is running. It is made of two wood handles covered with pieces of old bicycle tire. Through each wood handle is inserted a heavy piece of wire six inches long which terminates in a hook or eye at the top of each handle, and the eyes are con-

nected by means of a flexible electric light wire, several feet in length.

All of these tools I have made and used with good satisfaction and consider them well worth the time spent in their making by any one who works in connection with gas engines.

North Bend, Neb. G. G. M.

Is it Cheaper to Buy New Machinery or Employ Good Engineers?

EDITOR THE PRACTICAL ENGINEER:

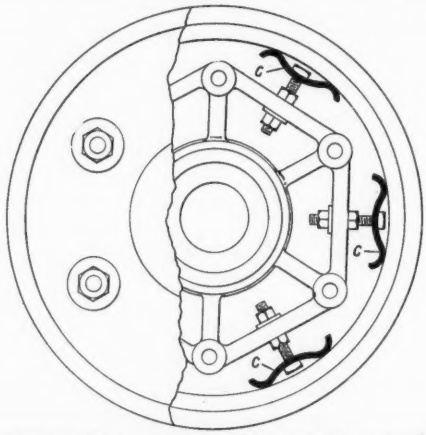
I read an article a short time ago in reference to skilled and unskilled engineers which leads me to believe that some people think that engineers grow on vines, and that you can pick one off as you need them. I think that most of them are picked, but not from vines, but from the army of men who are trying to perfect themselves by every means possible to understand the multitudinous duties which an engineer must perform.

It is surprising to find however, the number of men who are unskilled. Some of them think that all the engineer has to do is to put water in the boiler, shovel coal, open the throttle, and let her go; and when time comes, stop. It is a very expensive proposition to run with these men, as the following experiences will show:

Sometime ago I was working for a Norfolk, Va., firm repairing boat engines on the Albermarle Sound in North Carolina, when the firm sent me to Ropar City to find out the trouble with a ten-ton locomotive that they used in the woods. I went and found an engineer who was running, firing and repairing, who said he had just repaired the engine. All he did was to take the engine apart, and put it together, but in putting it together he forgot which eccentric blade was the go-ahead, and he had them hooked up wrong. One valve was wide open and the other blind. If the valves had been set right, he would have gone in the river back of him. Well, we got her together alright, and he felt pleased. About two months after, they sent again, and when I got to the mill, I found the same engineer, who said he could not keep steam in the boiler. The engine was a 10″ × 12″, directly connected to a 60″ saw, the whole unit being arranged to move it around. He fired up the boiler after I looked it over. There were no holes in the stack, the flues were clean, but the wood and sawdust were wet. After an hour he had steam. The foreman said that the same boiler had been in use in connection with a 7″ × 10″ engine, but it was now too small. After I had started the engine, I went outside, and there was a constant roar from the exhaust pipe. I examined everything carefully, but found the valves tight. I put the engine on quarter by fastening a bar in the saw teeth, and I found that the steam went straight through the piston rings.

The piston was of the style shown in sketch, the nuts and springs, CCC, being loosened up so that the piston rings did not act on the cylinder. I set them out and put on the follower plate and started up and the engine ran all right. After adjusting the safety valve on the boiler by letting up about one-half inch on the adjusting screw, and finding even then that it popped at 100 pounds, I bade him good-bye and wished never to go there again.

Four days later I was called there again. This time the engineer said he did not know what the trouble was, but on Sunday, he said, he fixed the engine fine, but she had run a little warm. He said the engine just groaned and groaned, and stopped dead. We put a bar and chain on the wheel, and four of us could not move the engine over. I took off the cylinder head and found the cylinder all cut up. I asked him how many times he had set out the rings, and he said three times, the last time on Sunday. The bill for boring the cylinder and making new rings on the piston cost $94, and yet such engineers lay the trouble to the machinist who repairs the engine, or the maker of the engine.



Tightening Piston Springs Cured Engine Trouble

Another little instance happened in Orange, N. J., a short time ago. I was sent out on a trouble job in a laundry where the engineer run the engine, fired the boiler, and run the washing machines. The rod brasses of the engine pounded so badly that the constant jar started the key in the cross-head, and finally cut it off so that the piston went through the head of the cylinder. I took it to the shop; repaired it and when I was about finished, I told the engineer to get up steam. He put in a lot of paper, about a load of wood and some coal oil, and he soon had a good fire. When I went to see how he was coming on with his steam, I noticed there was no water in the water glass. I asked him if he had water in his boiler, and he said he would, bye and bye, soon as he got 30 pounds of steam. He got it and put water in, but it all came out the back. We had to let the steam down, pull the fire, and expand all the lower tubes.

Of course, it is all to a firm's fancy as to whether it is cheaper to hire good men or to buy new engines and boilers every two or three years.

Orange, N. J. S. J. K.

Engineering Books Have Been Good to Him.

EDITOR THE PRACTICAL ENGINEER:

Under the heading, "A Talk With a Chief Engineer," in the October issue, the "chief" "knocks" engineering books rather hard, and I, who have been helped by them, wish to say that I disagree with him, as he seems to consider all books in one class. He does not distinguish between good and bad, but says "those books are full of algebraic formulae" and "unless you have a sound college education there is no use trying to read them." His opinion of practical

papers is all right, but I know the editor of this paper knows that a high class article dealing with thorough tests of engines, boilers, dynamos, etc., require at times the use of such formulae, and while the majority of articles may not require it, some do; also a paper or book cannot suit all classes of men, some readers preferring interesting reading, others something to study.

Further, I believe that any man possessing sufficient brains and "backbone" to be a good engineer can, if he will, become familiar with a few formulae which are in every-day use and find that such are a help to him in his regular work.

Another point I wish to bring out is that: Too many men expect one or two books to cover the whole field of engineering instead of getting a book simply dealing with one subject. Why not have the "chief" invest in one or two of the books recommended so highly in THE PRACTICAL ENGINEER; or, if he has a public library in his city, call there some time and spend an hour or two looking over their stock.

H. H. Y.

Trenton, N. J.

Lever Safety Valves.

EDITOR THE PRACTICAL ENGINEER:

For the benefit of some of your readers a little knowledge concerning the lever and ball safety valve may be found to be both interesting and valuable.

In the lever and ball safety valve the three principal things to be considered are distance, weight and pressure. The steam pressure on the lower face of the valve is a certain number of pounds, and to find this pressure the diameter of the valve must be squared and then multiplied by the

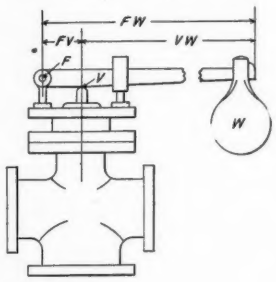


Fig 1

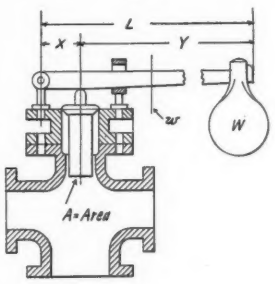


Fig. 2

decimal .7854, and the product obtained multiplied by the pressure shown by the gauge. The result will be the total pressure exerting itself against the bottom face of the valve. However, as the weight of the valve itself destroys as many pounds of the pressure equal to its own weight, the remaining pressure must be overcome by the weight and lever.

In Fig. 1, F is the fulcrum, V the point at which the pressure is exerted, and W the weight. The weight of the lever multiplied by its distance from the fulcrum is always equal to the weight on the valve multiplied by its distance from the fulcrum. The moment of the lever is found by removing and weighing it and also determining the length from the balancing point to the fulcrum F. This distance multiplied by the weight of the valve will give the effective moment of the lever. Therefore, to find the weight of the ball we have the following rule: (1) Find the area of the valve and multiply it by the pressure per square inch, and from this product subtract the weight of the valve. (2) Multiply this difference by FV, the distance from the fulcrum to the valve, subtract the moment of the lever and divide the product by FW, the distance from the fulcrum to the weight.

As an illustration let us solve the following problem: A 5-in. safety valve is required to blow off at 100 pounds per square inch, the last notch is 36 inches from the fulcrum; what will be the weight of the ball required to balance the steam pressure at 100 pounds per square inch with the ball 36 inches from the fulcrum? By referring to Fig. 2 let A = area of valve, P = pressure per square inch, W = weight of ball, X = 4", Y = 36" and L = X + Y, or 40". Assuming that the lever weighs 4 pounds and balances at w, or ½ of L, and the weight of the valve is 7 pounds, represented by H, we have the following formula:

$$P A X = w (\tfrac{1}{2} L) + W L + H$$

and, substituting the known values, we have

$$100 \times 19.635 \times 4 = 4 \times 20 + 36 \times W + 7$$
$$7854 = 80 + 36 W + 7$$
$$7854 - 80 - 7 = 36 W$$
$$36 W = 7767$$
$$W = 215.7 \text{ pounds.}$$

To find the area of safety valves for pressures from 75 to 125 pounds per square inch, divide the grate surface by 2, and for pressures exceeding 125 pounds divide by 3.

Roxbury, Mass. W. D. D.

A Durable Whitewash.

EDITOR THE PRACTICAL ENGINEER:

A whitewash, which I used in the boiler-room this spring, is the best I ever used: To 10 parts of freshly slaked lime add one part of best hydraulic cement and mix well with salt water. This whitewash, when properly applied, produces a clear white that does not easily rub or wash off. Other engineers will find it is O. K.

Exeter, Canada. N. L.

As John Lamb, the engineer, was shutting off steam in the engine of the bloom mill at the steel plant at Roebling, N. J., an explosion occurred which blew the engine apart and killed the engineer instantly. As he was alone in the engine room at the time, the exact cause of the explosion is not known.

A 300 horse-power boiler recently exploded in the steel plant of the Higgins Axle and Steel Co., Racine, Wis. A large number of men working near the boiler miraculously escaped injury. The back sheet of the boiler and fifteen tubes were blown out.

The explosion of a large fly-wheel at the plant of the Georgetown Oil Mills, Georgetown, Texas, demolished the engine room and three flying pieces did considerable damage to the other portions of the plant.

A boiler in the plant of the Pickney Iron Co., West Point, Tenn., exploded, and a portion was blown 75 yards, tearing off the top of a freight car in its travels.

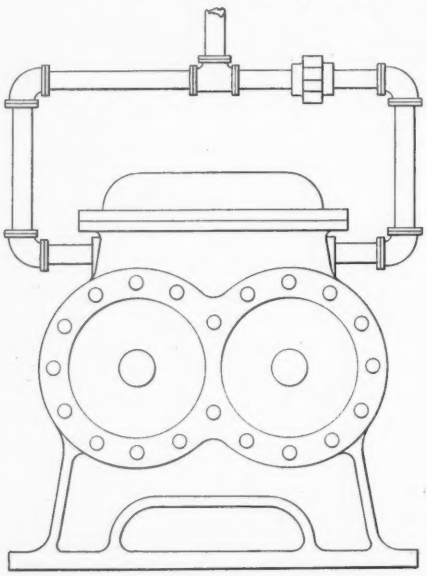
QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

What Advantage Has This Exhaust Connection?

EDITOR THE PRACTICAL ENGINEER:

Referring to "Visitor's" article in the May issue on the peculiar arrangement of the exhaust pipe of a pump, I once worked at a planing mill and the condensation from the dry kiln was returned to the boiler automatically by a duplex pump in connection with a receiver. The water was trapped into the receiver, the float opening the automatic



valve and starting the pump. The exhaust pipe was connected up from each side of the cylinder, the two ends being brought together over the steam chest with a union and tee, and then out through the roof to the atmosphere, as shown in sketch. As I have never seen the exhaust from a pump connected that way before, I would like to know what advantage is has, if any. L. C.

Montgomery, Ind.

What Is the Efficiency of a Separator?

EDITOR THE PRACTICAL ENGINEER:

Can anyone tell me what the efficiency of a steam separator is? The advantages of a steam separator are well known to every engineer. Dry steam is far better to deliver to an engine than wet steam. But what is the real efficiency of a steam separator? We know that in cases of priming, impurities will go through the steam line to the engine, and if this occurs often it will surely injure the cylinder. Rushes of water from the boiler to the engine will lessen its efficiency and will be a source of danger to the piston and cylinder heads. We are told that a steam separator will increase the efficiency of an engine, which is doubtless true, but to what extent? We are also told that it will be only a matter of a year or two and it will have paid for itself in the consumption of oil required by the engine alone.

The above are no idle thoughts. If an engine has been running for six or seven years without a separator and the engineer in charge informs his employer that a separator would be an economical proposition, the boss immediately asks what the saving will be, and if the engineer can not tell him, what is the use for him to say any more, if he has no data to go by and has no means of determining what the saving would be? I have looked over every kind of a catalog I can find on separators and not one solitary item can I find that will give the saving in steam consumption with steam at different degrees of saturation. If I am asked about the per cent. saving, I can make a guess of from five to twenty-five per cent., but when I am pinned down to facts I have to admit I don't know. I believe there are other engineers who would like to have more light on this subject, and if there are any of your readers who have had any experience before and after using and can give any figures, I would like to hear from them.

Letters from parties who have installed separators say that the best of satisfaction is being received and engines are working more economically than before installing them. Such letters are all right, but they don't help me to answer my employer as to how much a separator will save him, if he should desire to purchase one. I have had some loud wrangling, but I have not landed a separator yet.

Tottenville, N. Y. F. L. P.

Diameter of Boiler. Pitch of Stays.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer me the following questions:

1. Thickness of plate ⅜ in., double-riveted seams, steam pressure 100 pounds per square inch, tensile strength 60,000 pounds; what should be the diameter of boiler?

2. How many stays would you use, and the diameter and pitch of each to stay a surface 5 ft. 6 in. x 3 ft. 9 in., plate ⅜ in. thick, and steam pressure 150 pounds per square inch?

Detroit, Mich. J. L.

1. When the thickness of the boiler plate, tensile strength, allowable steam pressure and style of riveted joint are known, the diameter of the boiler may be calculated from the formula,

$$D = \frac{2\,T\,S}{P}$$

in which D = diameter in inches, T = thickness of shell in inches, S = safe tensile strength, and P = allowable steam pressure. Allowing a factor of safety of 6 and the efficiency of a double-riveted joint as 70 per cent., the value of S becomes S = 60,000 × 0.7 ÷ 6 = 7,000, so that

$$D = \frac{2 \times .375'' \times 7{,}000}{100} = 52\tfrac{1}{2}''$$

which is the diameter required.

2. In this problem it will be first necesssary to find the total area of stays required. This is done by multiplying the area of the sheet to be stayed by the steam pressure and dividing by 6,000, the allowable strain per square inch. That is, $66 \times 45 \times 150 \div 6{,}000 = 75$ square inches of stays. The diameter of each stay must be assumed. Suppose that 1½-inch stays are used, the area of each being 1.76 square inches, in which case $75 \div 1.76 = 43$ stays necessary. To find the proper pitch of the stays, divide the strain on one stay by the steam pressure and extract the square root; in this case, $1.76 \times 6{,}000 = 10{,}560$, the strain on each stay; $10{,}560 \div 150 = 70.4$, the square root of which is 8.4 inches, which is the required pitch of each 1½-inch stay. If the diameter of stay selected is smaller, the number of stays required will be greater and the pitch will be correspondingly less.

Area of Safety Valve. Electrical Horse Power.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following questions:

1. Give rule with example worked out for finding the area of segment of a boiler 6 feet in diameter, the distance from the top row of tubes to shell being 27 inches.

2. How do you find the diameter of a safety valve if the boiler has 36 square feet of grate surface?

3. How many amperes are equal to one electrical horse-power? W. G.

Brooklyn, N. Y.

1. A method for working out this problem is given on page 23, August issue.

2. A general rule which is often used is to divide the grate surface by 2, for pressures between 75 and 125 pounds per square inch and for pressures exceeding 125 pounds per square inch divide by 3. The result will be the area, from which the diameter can be found.

3. An electrical horse-power is equal to 746 watts. The number of amperes in a horse-power depends upon the voltage of the current, since the product of the volts and amperes is watts. If the voltage of the line is 110, then the number of amperes per horse-power would be $746 \div 110 = 6.78$ amperes.

Heating Problem.

EDITOR THE PRACTICAL ENGINEER:

Would you favor me with your opinion of the following: A building contains 91,186 cubic feet of space, chiefly for a factory except the front office and show rooms on ground floor. The building is not over-exposed, except the front of office and show room, which is all glass, facing north. It is proposed to heat this building with steam and to put in 3,332 linear feet of one-inch pipe (wall coils). There is a boiler 36 in. x 10 ft. 0 in., having 32 3-in. tubes, with a good stack 18 in. square and 50 ft. high. What is your opinion of the proposed radiation surface for the building, and also the capacity of the boiler for the work on low pressure gravity return system? E. N. G.

Toronto, Can.

Every problem in heating is more or less an individual one, but when other conditions are not mentioned, except the cubical contents of the building, it is a safe rule to allow one square foot of radiating surface for each 100 cubic feet of contents of building. In this particular case there will, therefore, be 912 square feet of heating surface required. The circumference of a one-inch pipe is about four inches, or one-third foot, so that the 3,332 linear feet will give a heating surface of 1,110 square feet, which should answer the requirements. As seven square feet of heating surface can be supplied by one square foot of boiler heating surface, the boiler should contain at least 159 square feet of heating surface. Taking the tubes of the given boiler as supplying the principle heating surface, the circumference of each tube will be about 9½ inches, or about ¾ of a foot, and since there are 32 of them, 10 feet long, the boiler-heating surface will be $¾ \times 32 \times 10 = 240$ square feet, or sufficient to supply the 3,332 linear feet of piping.

The Favorite Reversible Ratchet Wrench.

A reversible ratchet wrench which can be used in narrow places and which gives a continuous motion until the nut is seated, is shown in Fig. 1. It is known as the Favorite Reversible Ratchet Wrench. From the illustration, it can be seen that the nut is encompassed on all sides by the head, and the opening through the head allows the bolt to pass clear through it.

Fig. 1. Favorite Reversible Ratchet Wrench with Head

Fig. 1 represents the wrench as made in sizes Nos. 1, 2, 2½ and 3, the length of the handle being 15 in. in the No. 1 size, and 28 in. each in the others. The handle is in one piece and without joints to weaken it. The reversing attachment is near the head, and so guarded as to prevent likelihood of injury. The heads are made to accommodate square nuts on one end and hexagon nuts on the other, or hexagon nuts on both ends so constructed as to have the opening clear through the head, thus allowing the bolt to go through it and allowing a jam nut to be seated if desired.

The wrench with the open heads is serviceable for engine builders, machine shops, bridge builders, contractors, and wherever heavy work is handled, and many nuts of uniform sizes are encountered. Some of the advantages of this construction are that the wrench entirely compasses the

nut and prevents slipping and marring, this being especially important where new work is being assembled, or where nuts are being removed from cylinders to be later replaced It is also serviceable in limited spaces, as a slight travel of the handle will catch one tooth of the ratchet and cause it to work. The movement can be reversed by throwing over the lever.

In seating or removing nuts the motion is continuous until the operation is completed, thus economizing time. The No. 1 size takes three different heads, the No. 2 can be furnished with five heads, and the Nos. 2½ and 3, three heads each, the openings of all in the regular sizes being designed to fit standardized nuts. One head accompanies each head regularly, but any or all of the various heads can be furnished.

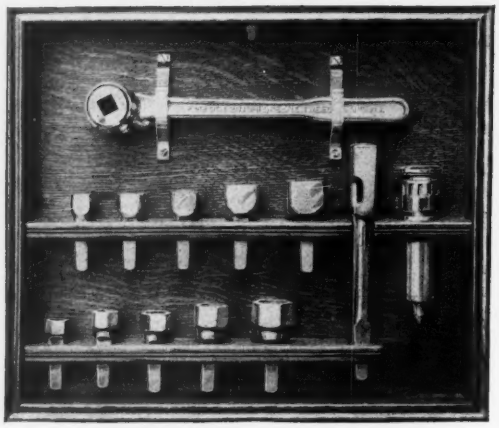


Fig. 2. Wrench and Attachments on Oak Board

Fig. 2 illustrates the wrench complete mounted on an oak wrench board suitable for hanging in an engine room, or the handle with any of the parts can be furnished, according to specification. This wrench is finished either in japan or nickel-plate. The handle is 15 in. long, and the sockets will fit U. S. standard square nuts for 3/8, 7/16, 1/2, 5/8 and 3/4-in. bolts, another set fitting hexagon nuts for the same sizes of bolts. The complete set includes an 8-in. extension socket and a 7-in. drill head for square shank drills.

Green, Tweed & Co., 109 Duane Street, New York, are the manufacturers.

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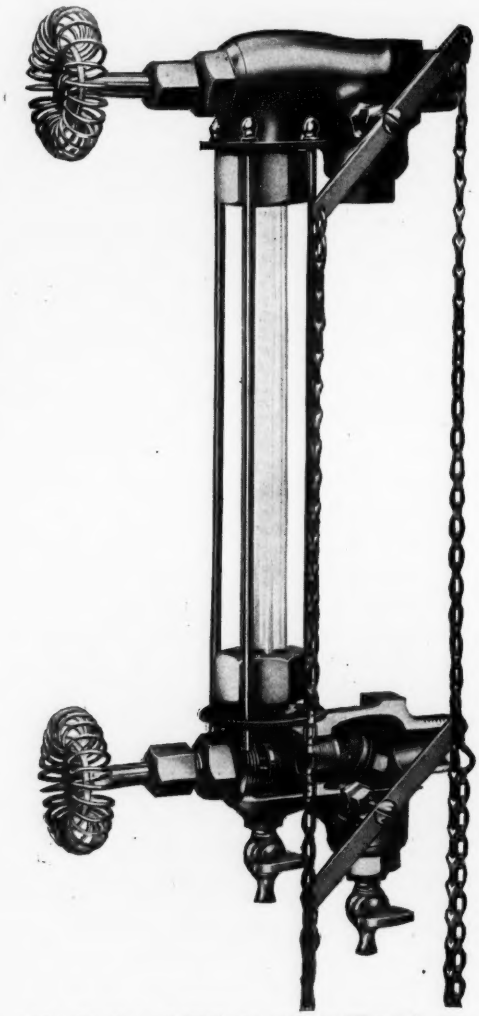
The Northern Self-Closing Safety Water Gauge.

The accompanying illustration shows the Northern Self-Closing Safety Water Gauge, which has been designed and constructed for the purpose of avoiding the many accidents which are likely to occur to persons and property, owing to the breaking of a water glass.

The feature of this water gauge lies in the combination valve, the lower one of which is shown in section. The object of these valves is to combine a water gauge and self-closing valve into a safety combination which permits of being screwed directly to the boiler or water column.

In case the glass should break from any cause, the valves are so designed that they are closed instantly, which prevents the throwing of the glass or the escape of steam, both of which may be very dangerous to the attendant. The safety check valves are always open when the water glass is operating under its normal conditions, but they close with one pound difference of pressure which makes them available for high and low pressures.

By means of a wheel, or the bar and chain, the valves can be forced to the open position and held open in case they should close when blowing down the water gauge, but under no conditions can they be forced shut by any external manipulation, thus preventing a false water level and making them fool-proof. After a new glass has been put in after breakage, the valves open automatically and gradually



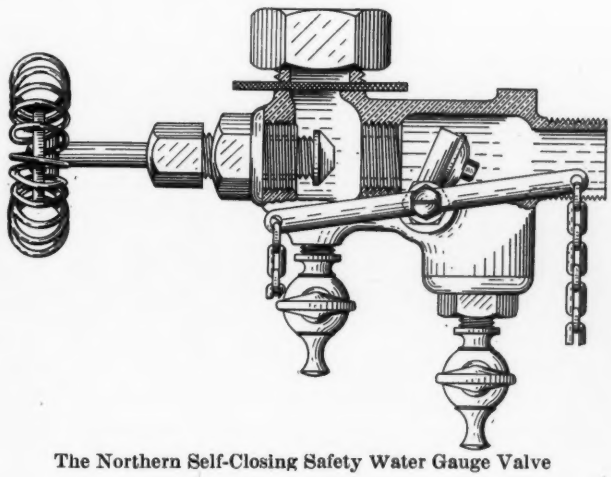
The Northern Self-Closing Safety Water Gauge

until the pressure on both sides of the valve are the same, when they stand at full-open position. This gives a period which allows the glass to warm up before the full pressure is thrown upon it.

The lower safety check valve is provided with a drain cock which is used for blowing out any sediment that may collect in it. When the gauge glass is blown down it may be done by operating each valve separately. A half-turn of the hand wheel or bar leaves the valves in a position for closing automatically.

The chain and levers on this device are not used as quick

openers, or vica versa. They are only used to force open or hold open the valves when blowing down the water gauge, and are therefore used for the opposite purpose to the ordinary chain-pull shut-off.



The Northern Self-Closing Safety Water Gauge Valve

The gauges are tested to 700 pounds hydraulic pressure and are made of bronze metal, the valve seats and disks being made of brass, nickel-plated. This device is approved by all boiler insurance companies, State Board of Boiler Inspectors, and Government Inspectors of Steam Boilers. The Northern Specialty Co., 69 Columbia Street, Utica, N. Y., are the manufacturers.

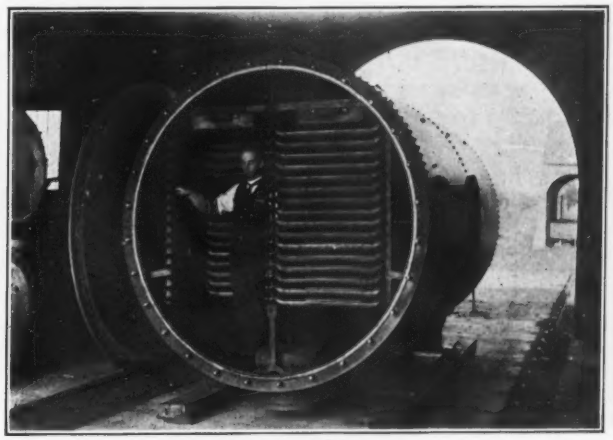
The Hoppes Feed Water Heater.

The accompanying illustration shows a large size Hoppes exhaust steam feed water heater of 16,000 horse-power capacity, built for the Boston Elevated Railway Co. It represents one of the numerous sizes of feed water heaters manufactured by the Hoppes Manufacturing Co., Springfield, O., who make heaters of this type ranging from 50 to 40,000 horse-power.

As these heaters are of the open type, the feed water comes in direct contact with the exhaust steam as it passes through the heater. The feed-water supply is controlled by a regulating valve which is operated by a float located in a separate float chamber outside the heater, the regulating valve being of the double-disc, balanced type. The valve and seats are constructed of bronze and are self-centreing, so that they can seat in any direction.

The regulating valve is located so that it is protected by a double water seal, which eliminates any trouble that might arise from expansion and contraction, and avoids the collection of lime on the working part of the valve. The water seal prevents the exhaust steam from coming in contact with the valve parts and allows them to remain at the temperature of the inlet water to the heater.

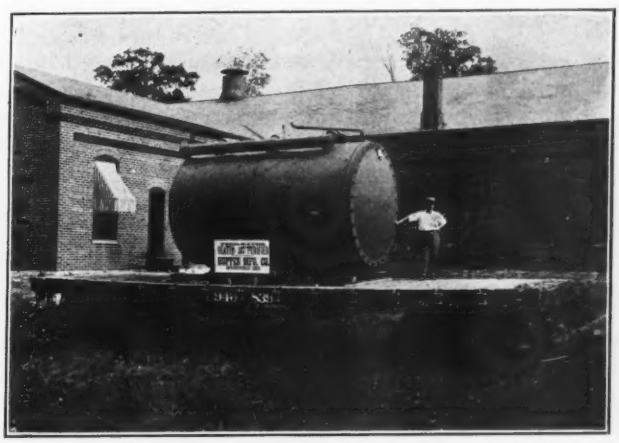
The feed water, after passing through the regulating valve, is distributed along the feed pipe and flows through openings which distributes it to the cast iron feed pans, of which there are a large number. The pans are designed to give a large surface so that the water will flow at a low velocity and follow the bottom contour of each pan in a thin film before dropping off into the next pan beneath. While the water is following the underside of the pans, the exhaust steam comes in direct contact with it and heats it to the temperature of the exhaust steam. The feed pans at the top, into which the feed water is distributed by means of ell-shaped pipes, are made somewhat deeper than the other pans, thus forming a settling chamber for sediment



16,000 H. P. Hoppes Feed Water Heater Constructed for the Boston Elevated Railway Co.

which may have entered in the feed water. The feed pans also serve to distribute the water to each tier of pans below.

Lime and other solids, which are held in solution in the feed water and which are liberated by the temperature of the exhaust steam, form in solids mostly on the underside of the pans, which does not affect the efficiency of the heater, as the direct action of the steam on the water always continues.



16,000 H. P. Hoppes Feed Water Heater Ready for Shipment

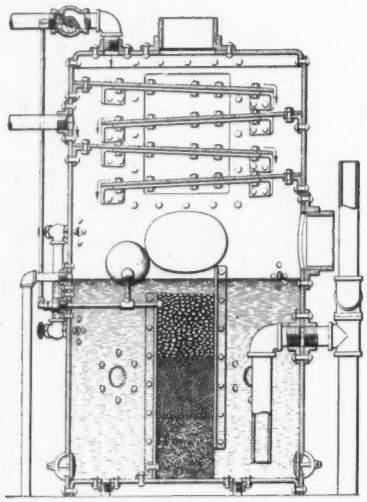
The shells of these heaters are cylindrical, with heads bumped to a radius. For localities where the water is of a corrosive nature all parts of the heater which comes in contact with the water are constructed of cast iron. In order to increase the capacity of the overflow pipe by increasing the head on the outlet without causing the water to rise higher than the heater, the heater is equipped at the back

head with an overflow dam, which also acts as a surface skimmer. The oil from the exhaust steam is drained into this overflow dam space, but the oil can be separately drained with an independent pipe as conditions require.

The McKnight Feed Water Heater and Purifier.

The McKnight Feed water Heater and Purifier, which is shown in the accompanying illustration, combines in one combination an open feed water heater, purifier, muffler, oil separator, settling chamber, return tank and filter. It may be used as a vacuum heater, condensing just enough steam to bring the feed water up to the proper temperature, or it may use all the steam from the exhaust.

The exhaust steam enters the side of the heater and goes out the top, and the water enters the top of the heater at one side. The water falls on the inclined shelves, passsing in its course four times across the heater and then into the



The McKnight Open Feed Water Heater

settling chamber, which allows the sediment to fall to the bottom and be blown out. When the settling chamber fills, the water flows down through the filter and out at the bottom of the filter to the pump suction. The steam mingles with the water at all times, the formation of scale or sedident not affecting the efficiency of the heater at any time.

The float is connected to the valve in the water line and controls the height of water in the heater. Should the float, for any reason, become disabled or the water shut off, it is impossible to pump the heater empty because, as soon as the water level drops to the elbow in the suction line to the pump, the vacuum is automatically broken. This also prevents any cylinder oil, which might be on the surface of the water, from getting to the bottom end of the suction pipe.

The heaters are built of boiler iron and are equipped with feed water control, water glass and the necessary flanges for the exhaust and feed pipes. They are manufactured by Walter J. McKnight, 179 Washington Street, Buffalo, N. Y., who guarantees that the feed water will be heated within one-half degree of the temperature of the exhaust steam without back pressure, and that it will be free from oil or sediment.

The Dunham Vacuo-Vapor Systems of Steam Heating.

A new method of steam heating has been put upon the market which embodies some novel features in which it is claimed that a difference in pressure between the steam and the return pipe of any gravity system is maintained without mechanical means of any description. It is also claimed that the system will operate either under a vacuum or as a vapor or pressure system, said changes being affected automatically and without attention on the part of the operator.

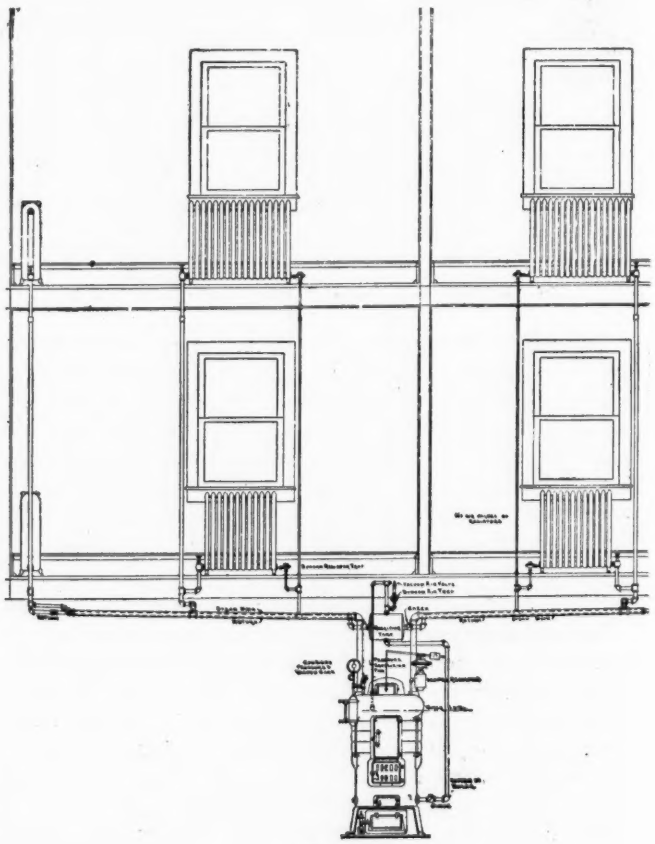


Fig. 1

Air vents on each radiator are entirely dispensed with and the openings plugged. Accumulations of air, together with the condensation, is forced into the return pipes and down to the basement where it is separated—the air passing through the thermostatic vacuum air valve to the atmosphere and the water passed into the boiler to be used again.

The system is said to give off a uniform heat as each radiator is kept filled with live steam at all times, whether operating above or below atmosphere, save when the supply thereto is throttled, allowing of lower temperature, or when the radiators are shut off entirely.

Referring to illustration No. 1, one form of application of this system to a residence is shown. Illustration No. 2 shows in detail the vacuo-vapor attachments, and illustration No. 3 the Dunham radiator trap as employed in connection with the return end of the radiator.

In explaining the action of the system it is assumed that steam is generated in the boiler and passed upward through

feed pipes into the radiator. As the steam enters the radiator, the air is displaced freely, escaping through the thermostatic trap which remains wide open when cold, and into the return and to the receiving tank "B."

When the system is working above atmosphere pressure the air is free to escape from the reservoir through the thermostatic air valve "B" and out the vacuum valve "A" to the atmosphere.

After the water and air have passed out of the radiators, steam comes in contact with the thermostatic trap, causing it to close, holding all the steam back where its heat is rapidly absorbed from the radiator, and when air and water have again collected the action of the trap is repeated.

Condensation passes to the receiving tank only after its heat has been all given up, where it accumulates until such a quantity of water has been evaporated from the boiler as

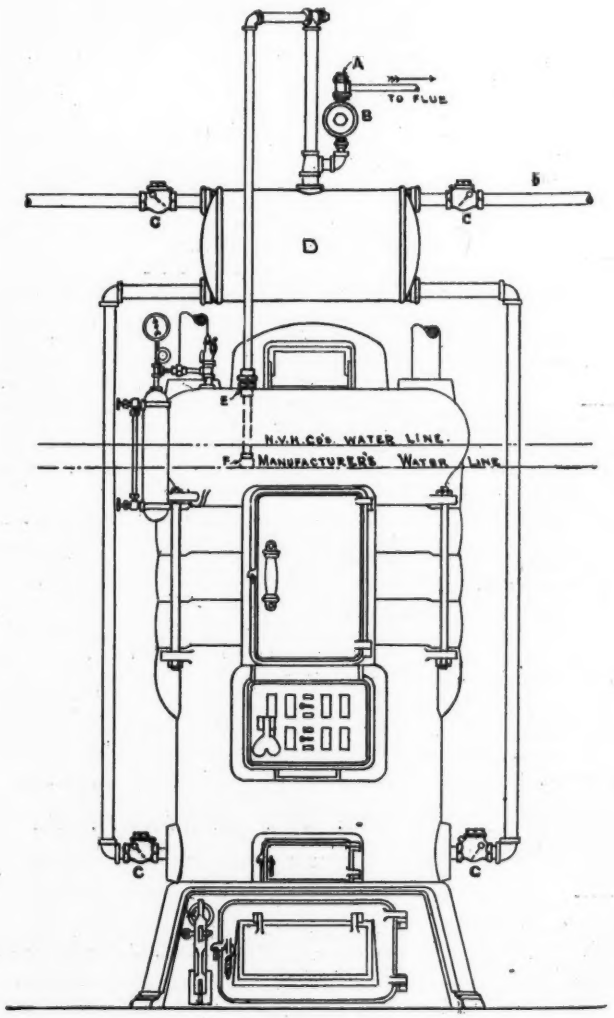


Fig. 2

will lower the water line sufficiently to uncover the end of the equalizing tube "F" which connects through the boiler coupling "E," forming a loop over and down into receiving tank "D." This opens a passage for live steam to enter the tank from the boiler and equalizes the pressure therein with that in the boiler, thereby permitting this water to flow down into the return pipes and through the check valves "C" into the boiler, raising water-line and again covering tube end "F" and protecting it against the passage of steam by water seal.

After the discharging process, the steam which displaced the water in the receiving tank condenses, forming a partial vacuum therein which relieves the check valves "C" on end of return pipes entering the tank, and permits accumulated

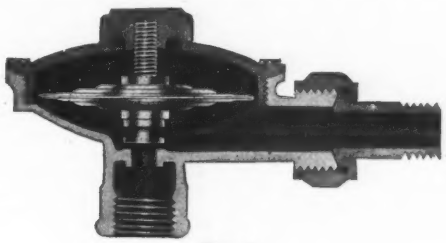


Fig. 3

air and water of the return pipes to be forced into this receiver, at the same time relieving them of any pressure and putting them under the same partial vacuum conditions which may exist in the receiving tank at this time. Somewhat smaller piping is used on this system when compared with the usual gravity system.

It is claimed that the system should be operated during the day on a pressure at the boiler or from atmosphere to one pound, and that the damper regulator be adjusted to control the steam at this point, and that the economy in the system lies in regulating each individual radiator by throttling down the inlet valve and using the steam expansively in the radiator so it will give off just the desired amount of heat wanted for each room, but at night greater economy is shown by banking the fire, closing off drafts and operating the system under a vacuum. It is claimed the temperature will be such as would be particularly desired for sleeping, which heat would be obtained through circulating the steam under low temperature by absorbing heat units from the gases of a banked fire of correspondingly low temperature. As no steam or water can escape from the system, it is seldom, if ever, necessary to replenish.

In large installations, such as would be applied to office buildings, institutions, hotels, etc., and where exhaust steam is available, each radiator is equipped with a radiator trap at the return end and the returns combined into one or more larger one which lead to a combination receiver and air relief, which is applied close to the pump.

The devices and attachments used on this system are manufactured by the National Vacuum Heating Company, Marshalltown, Iowa.

The engine that runs the paper machine in the plant of the Public Service Corporation, at Marietta, Ga., recently exploded, and was completely destroyed, resulting in a damage amounting to about $10,000.

A boiler in the silk mill at Erdman, Pa., exploded recently, killing two men and injuring three others.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

In their advertisement on page 63, the Holmes Metallic Packing Co., direct special attention to the Holmes Packing Ring and the way it is cut to insure its wearing round and to prevent leakage of steam. This feature together with a complete description of the Holmes packing is shown in their catalogue, which they will mail to any reader of THE PRACTICAL ENGINEER upon request.

The "Combination" Flue Scraper and Brush, made by A. W. Chesterton & Co., 64 India Street, Boston, Mass., is meeting with high favor among engineers. The special advantage of this cleaner is the position of the spring, which is protected from the heat, so that it always retains its maximum efficiency. Another feature is that the spring can readily be adjusted to any desired tension demanded by the condition of the flues.

Squires' Steam Specialties, including the Squires' Steam Traps, Squires' Boiler Feedwater Regulator, Pump Governors and Reducing Valves are shown in a richly-printed catalogue, issued by the Strong, Carlisle & Hammond Co., 346 Frankfort Street, Cleveland, Ohio. The Squires' specialties are interesting, because of their marked originality and general excellence of design. The catalogue gives a complete detailed description of each specialty with dimensions, capacities, price lists and many illustrations. A copy will be mailed to those interested upon request.

Mansfield Ball-Bearing Grates are described in detail in a catalogue issued by the manufacturers, Wm. E. Rider & Co., Mansfield, Mass.

The "Heintz" Steam Trap is operated entirely by contraction and expansion, as the condensation accumulates and lowers the temperature, the valve opens at the discharge, closing immediately when the condensation has passed off. A booklet describing it in detail will be mailed to any reader by the Wm. S. Haines Co., 136 South 4th Street, Philadelphia. Ask for booklet P.

The American Boiler Economy Co. have removed to new offices in the North American Building, Philadelphia.

American Goetz-Gasket and Packing Co. have moved to 527 East 149th Street, New York City.

Suction Gas Producers are interestingly described in a new catalogue, published by Wile Power Gas Co., 69 Cutler Building, Rochester, N. Y. It tells what Producer gas is. How it is made, its cost, how to use it and the net results, which are things worth knowing. Those who don't know them, especially the Wile System, should write for a copy of their new catalogue.

The Little Giant Injector, also a line of Ejectors; a boiler washer and tester, check valves, etc., are described in catalog A 2, published by Rue Mfgr. Co., 228 Cherry Street, Philadelphia.

The *Penberthy Engineer and Fireman* is a 32-page monthly journal for engineers and firemen, published by The Penberthy Injector Co., Detroit, Mich. Sample copy will be sent upon request.

Mr. Walter B. Snow, who for many years has been in charge of the Publicity Department of the B. F. Sturtevant Co., and who is widely known as an engineer of marked ability, has opened offices at 170 Summer Street, Boston, for the promotion of Publicity Engineering. The title of Publicity Engineer, as Mr. Snow explains, properly belongs to an engineer who has devoted himself to publicity as distinguished from an advertising writer who has acquired some knowledge of engineering. Mr. Snow is particularly well equipped for this class of work. He is a graduate of the Massachusetts School of Technology, has had experience as a lecturer before engineering societies, has been a liberal contributor to the technical press, author of Steam Boiler Practice, and the Treatise on Mechanical Draft, and as a member of the Publication Committee of the A. S. M. E. His purpose as an independent Publicity Engineer is to conduct, for a stated sum, annually or otherwise, the entire publicity of manufacturers of machinery and allied products. He has issued a neat booklet, entitled "Productive Publicity," a copy of which he will mail to any manufacturer who is interested in the subject of better publicity.

New illustrated circulars describing the Perfection Shaking and Chopping Grates, telling how it will burn all grades of fuel better and more economically than other grates; how it saves on repairs, and giving remarkably strong guarantees of fuel saving and increased efficiency, have been received from the Perfection Grate Co., corner of Lyman & Chestnut Streets, Springfield, Mass.

The Trill Indicator Company, Corry, Pa., are sending out a circular advertising the Triumph Indicator. They will send them to any responsible person for ten days' free trial. If not exactly as represented, same to be returned at their expense.

"Heating Boiler Feed-Water Where the Main Engine is Run Condensing" is the title of a treatise recently published by the Harrison Safety Boiler Works, Philadelphia, Pa. It is shown that by using the exhaust steam of boiler feed pumps, circulating pumps and air pumps for preheating the boiler feed-water, the efficiency of these pumps becomes much higher than that of the best triple-expansion, condensing engine. At the same time, steam-driven machines of this character are much less expensive in first cost and the cost of attendance, are less liable to get out of order and may be operated when the main engine is standing idle, which, of course, is not the case with directly-connected or electrically-driven auxiliaries. The illustrations and text cover the engineering phases of the subject, including methods of operating barometric and surface condensers, the effect of air in the condensers of steam turbine plants, description of a typical street railway power plant, etc. Copies of this booklet will be supplied upon application.

Readers who are interested in Damper Regulators should write for the new circular describing the Stillman-Carmichael Improved Automatic Damper Regulator, issued by the Stillman-Carmichael Co., 19 Pearl Street, Boston, Mass.

The Bristol Co., Waterbury, Conn., are issuing a new catalogue, describing the Bristol Feed-Water Long Distance Recording Thermometer.

Those who have not yet written for one of the new catalogues, published by Liberty Mfg. Co., 6409 Susquehanna Street, Pittsburg, should do so before the edition is exhausted.

Automatic Air Valves, Paul Valves, Thermostatic Valves, and all kinds of pressure and recording gauges, including steam, water, vacuum, electric alarm, illuminated dial gauges, and numberless others, for every service, are shown in a new catalogue just received from the National Steam Specialty Co., 234 East Washington Street, Chicago, Ill.

John R. Livezey, the well known pipe-covering man and expert on cold storage insulation, has moved into his new building at 1933 Market Street, Philadelphia, where he occupies the entire building. This gives Mr. Livezey immense storage capacity and greatly increased office room both of which were necessary for his large and rapidly growing business. Mr. Livezey makes a specialty of Nonpareil Cork products and of all kinds of Magnesia and Asbestos insulating materials. Don't forget the new address, 1933 Market Street.

That an ounce of prevention is worth a pound of cure, is an old saying, but it never was more true than in these days of increased steam pressures around power plants. Other persons may prescribe the cure, but the H. & M. Valve Co., of 25 Broad St., New York City, have all kinds of prevention in their different makes of H. & M. Valves. The valves supply safety in case a tube in a boiler gives way, or should a steam header burst, the valve will close, which will prevent the emptying and shutting down of the boilers. A copy of a circular describing the action of these valves will be sent upon request.

The Crescent Steam Condensation Meter for measuring the amount of steam heat furnished to buildings, dry rooms, or any steam heat radiating apparatus is interestingly described in a circular issued by W. H. Pearce & Co., 261 Dearborn St., Chicago, Ill. The Pearce Co. are also the manufacturers of the Crescent Steam Trap and other devices for the economical transmission and use of steam or hot water for heating purposes.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co., Tacony, Phila., Pa.

WANTED—Engineers and Mechanics to make big money selling O. K. Hand Soap. A 10-cent Can will instantly remove more dirt and stains from the hands than 4 cakes of any soap made, and it will not injure the most delicate skin. Small sample free. O. K. HAND SOAP CO., 570 Columbus Ave., Boston, Mass.

JUST OUT—PATENTED
THE STEAM ENGINEER'S SLIDE RULE

Gives Mean Effective Pressure of Steam or Air in one setting. F. F. NICKEL, 27 Winans, Street, East Orange, N. J.

PATENTS Watson E. Coleman, Patent Attorney, Washington, D. C. Advice free. Terms low. Highest ref.

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Attorney-at-Law and Solicitor of Patents.
Patents secured promptly and with special regard to the legal protection of the invention.
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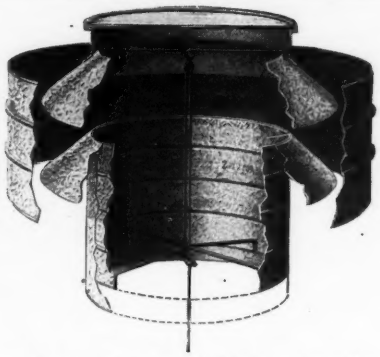


Sectional view showing glass top with sliding-sleeve damper (patented)

Burt Ventilators

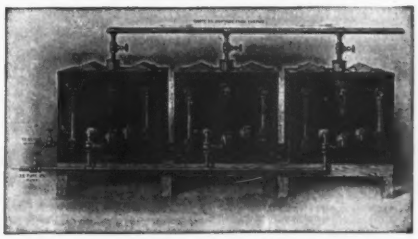
automatically draw out of buildings all impure air, smoke, steam and gas with no expense of operation. They are easily the most effective and cheapest devices of the kind made. They can be had with or without glass tops, the former combining skylight and ventilator.

The Jones & Lamson Machine Co., of Springfield, Vt., have recently ordered eighty 20-inch metal-top ventilators for use on their new shops.

We have an 80-page Catalog. Do you want one?

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.



Unit Oil Filters

will clean your waste or drip oil, returning it absolutely pure and saving 50 per cent. to 90 per cent. on your oil bills. The process can be repeated over and over with the same result each time. One "Unit" or an indefinite number can be used, each one having a capacity of from 200 to 250 gallons per 24 hours.

The Calumet & Hecla Copper Mining Co., one of the largest mining concerns in the world, recently ordered seven "Units." WHY?

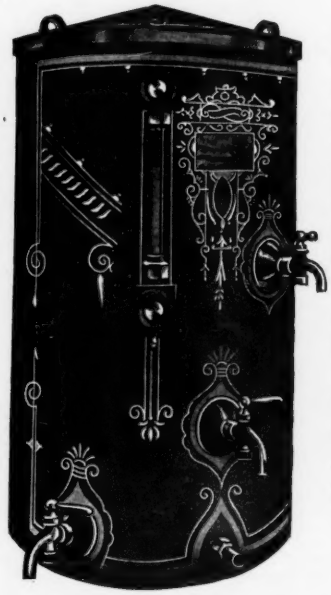
Write for our 80-page Catalog. FREE.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

Cross Oil Filters



allow using your oil many times over by straining it through waste and washing it in pure warm water. All dirt and grit is removed and the oil is returned as clean as when new. The cost of operating is only a few cents a year for waste. The work of the "Cross" is perfect and it always works.

You need our 80-page Catalog. It's free.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

Burt Exhaust Heads

effect complete separation of oil and water from exhaust steam, keeping roofs and walls dry and free from decay and reducing fuel bills by returning condensation to boiler. This is the most satisfactory device known for muffling the exhaust pipe.

The Pullman Co., Chicago, recently ordered the 30th "Burt" from us.

Hustle and get our large 80-page Catalog. A postal will do it.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

A new engine plant has recently been established at Chester, Pa., by the Jacobson Engine Co., for the manufacture of the Jacobson Automatic Gas Engines. These engines are for all classes of work where medium and large sizes are required, and are designed for close speed regulation. They are equipped with an improved scavenging arrangement, which clears the combustion chamber of all burnt gases by means of a draught of pure air just before the mixture is admitted, which is of the utmost importance, especially where producer gas is used. The company will make a specialty of engines for producer gas, but their engines will operate equally well on natural blast furnace or illuminating gas. These engines will be built under the supervision of Mr. Chas. Jacobson, who has spent years in the designing and building of high grade gas engines and whose ability in that line is so well known that the new company already received many orders for engines ranging in size from 30 to 300 hourse power each, and are running their shops to the limit of their capacity. The company have issued a large pamphlet, describing their engines more fully, a copy of which they will mail to ay one interested. Address, Jacobson Engine Co., Chester, Pa.

Every engineer should have an indicator and should know how to use it intelligently. Without an indicator, steam engineering is largely a matter of guess work, it is impossible to know the exact condition of your engine and equally impossible to fully understand the action of steam in the cylinder. The cost of an indicator or a pair of indicators is so much lower than it was years ago that there is now no good reason for any engineer being without one. The improved Robertson-Thompson Indicator is fully described in the latest catalogue of Jas. L. Robertson & Sons, 40 Warren Street, New York.

Petit & Son, Peru, Nebraska, recently installed a Buckeye Automatic Boiler Skimmer. On September 23d they wrote the manufacturers of the Buckeye Skimmer as follows:

The Buckeye Boiler Skimmer Co.,
Toledo, Ohio.

GENTLEMEN:—Please find enclosed check for $—— to pay for skimmer. We opened our boiler just 30 days after skimmer was installed, and in operation, and found practically no mud in it.

We always had to open, clean and wash our boiler at least every ten days, and we would find braces at both ends of the boiler piled high with mud, and also a thick layer of mud over the bottom, and we always used the blow-off valve very frequently.

We are much pleased with the skimmer, and have recommended and described it to several engineers and owners of steam plants here. We have given the skimmer a good, severe test, and we have run the boiler all day every day in the week and every night until 11 o'clock for the last 30 days, and have found only a small amount of settling just spoken of, not to exceed a quart altogether, and this without using the blow-off valve either.

Wishing you the success the skimmer merits, we are, yours truly, PETIT & SONS.

The Northern Specialty Company, Inc., 69 Columbia Street, Utica, N. Y., have installed their "Northern" Self-Closing Safety Water Gauges on the boilers in many manufacturing and heating plants in Hartford, Conn. (The Insurance City of the United States). They have been placed on the boilers in the school buildings, Trinity College, county buildings, hospitals, asylums, Aetna Life Building, and other insurance buildings, and the balance on the large manufacturing plants there. Their new illustrated catalogue, No. 3, just issued, will be mailed upon request, also the Hartford list of users, if desired.

In the Water Motor advertisement of Mr. L. C. Hill, maker of those little WaterMotors, to attach to the faucet for polishing, grinding, running sewing machines, we made an error, so that it read H. C. Hill. Those who have written to the correct address without reply will kindly write again, addressing L. C. Hill, Newark, N. J.

As a leather preservative it is generally admitted there is nothing to equal Pure Neatsfoot Oil. Its application to leather belts puts back into the leather a great deal of the natural strength and vitality lost in tanning. "Neat" is the old English word for cattle, therefore Neatsfoot Oil is in reality cattlefoot oil. The fats from the feet of cattle are first rendered, then pressed for a yield of oil (Neatsfoot). This crude oil is next "grained," then placed in cold storage and frozen, then pressed again, a smaller and purer percentage of oil being obtained.

This oil is afterward refined and finished by by sun bleaching until in its finished state it is water white. The product in this state is the basis of the new belt dressing Ox-Oil-Ox put on the market by F. S. Walton Co., of Philadelphia, and it is testified by those who have used it for the past two years to be better than anything they have ever before tried; worn-out belts becoming soft and pliable under its continued application until they look as though they would last for many years, not only that, but the general efficiency of the whole plant is materially helped because the ingredients used in connection with the Neatsfoot Oil increase the driving and traction qualities of the belts, giving them a firmer grip on the pulleys.

The history of the Ox-Oil-Ox is rather interesting, and illustrates this company's characteristic determination to overcome difficulties. Ox-Oil-Ox is the outgrowth of trouble encountered by them in their cold storage plant. The system used is the carbondale absorption, and briefly, the cold air is made in one compartment and fanned through large funnels into the cooling rooms. The fan is operated by an engine, and is connected by a leather belt. For months and months their chief engineer was in despair through the continual breakage of belts so placed, caused by the constant drip of melting ice clinging to the coils directly above it. He tried everything in the shape of a belt dressing which he believed to be worth a trial, including castor oil, but was unable to overcome the trouble. In the meantime experiments were being made in their laboratary with the view of producing some appropriate material that might overcome the annoyance and expense. After months of patient labor the material which they have branded Ox-Oil-Ox was evolved, a working sample given to the chief, and thoroughly tested. The results proved so satisfactory that its use has been continued on all the belts in their plant. A slipping belt is an unheard-of thing, and they have been using the same one to run their fan in the ice plant for over a year and a half, and it looks good for many years' service to-day.

Finding this material so eminently satisfactory to themselves caused the company to decide to place it on the market, and up to the present time all who have used it have made reports to the manufacturers, differing only in degree in their praise of the article. The Walton Co. have such faith in their new product accomplishing for others what it has accomplished for them that they are willing to send working samples to anyone having trouble with their belts, absolutely free.

Goetze Profile Elastic Copper and Metal Gaskets and "Goetzerit" Flange Packings are entertainingly and instructively described in a new booklet issued by the American Goetze Gasket & Packing Co. for free distribution to engineers and steam users who are sufficiently interested in the subject of high grade joint packings to write for a copy.

The Northern Specialty Co., 69 Columbia Street, Utica, N. Y., have sent us a letter which they recently received from Mr. H. M. Martyn, consulting engineer N. Y. State Dept. Public Buildings, endorsing the Northern Self-closing Water Gauge. Copy of the letter follows:

DEAR SIRS:—I am more than pleased with the new safety water-gauges which we have lately placed on the five boilers in the the New York State Capital boiler house, on Hawk Street. They have already demonstrated their usefulness, and when a glass breaks it is hardly possible to distinguish the fact, because one only hears the "pop" of the bursting, the steam and the water being instantly shut off. Your apparatus is nearer perfection than any I have seen or heard of in all my years of practical experience, and you may quote me as saying that there is no possible reason for any of the dangers and annoyance contingent upon the breaking of glass water-gauges if your safety fittings are used.

I have recommended your apparatus to the other departments of the State, feeling that I am doing the State a good turn by doing so.

Yours very truly,
H. M. MARTYN, F.C.S., L.R.C.P.,
Engineer.

The Otis Tubular Feed Water Heaters, Purifiers and Eliminators are instructively described in their catalogue, which gives sizes, capacities, weight, prices and full information for those considering the purchase of a new heater. Write for a copy to the Stewart Heater Co., 7 Norfolk Avenue, Buffalo, N. Y.

The Elastic Metallic Packing Co., 407 Cherry Street, Philadelphia, manufacturers of the new Elastic Metallic Ring Packing, tell us that the demand for this style of packing has been enormous, and that the results obtained from its use have been highly satisfactory to those who are using it. The feature of this packing which commends it to engineers is that it is all metallic, yet is made in ring form; the rings being sufficiently elastic to spring over the rod and apply the same as fibrous rings. A booklet describing this packing more fully is issued by the company.

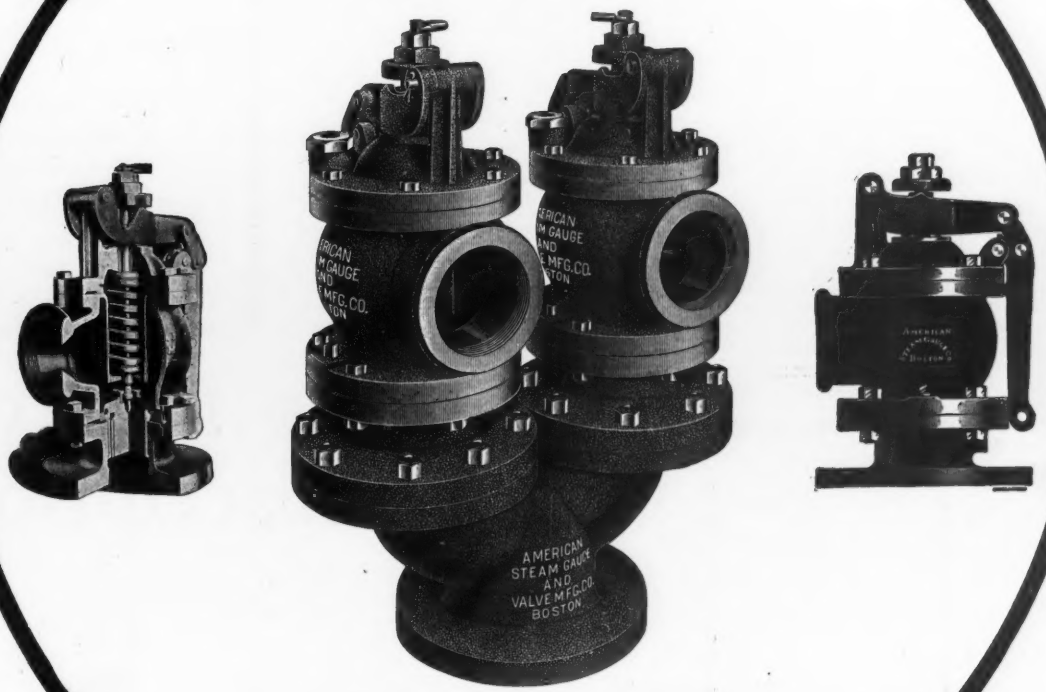
"Rex" Metallic Engine Packing is made of a special proved metal alloy cut into fine strips or shaving and impregnated with flake-graphite and cylinder oil. The nature of this packing is such that it may be used in any sized stuffing box without measuring. All that is necessary is to ram the shavings of packing into the stuffing box with a piece of wood shaped to take the curve of the box and then

"REX" METALLIC PACKING

apply one ring of fibrous packing to prevent the direct contact of the glands with the metal, then after allowing the material to warm up it is claimed that a safe reliable and tight packing is obtained. The makers say that this has proven to be an excellent packing for very high pressures and high temperatures, and that under proper conditions it will last a long time. Rex Packing is manufactured by the American Goetze-Gasket and Packing Co., 527 East 149th Street, New York City.

THE AMERICAN

"SPECIAL"



TWIN POP SAFETY VALVE

WRITE FOR CIRCULAR 1—P

The American Steam Gauge & Valve Mfg. Co.

208-220 Camden Street, Boston, Massachusetts

New York, 26 Cortlandt St. Atlanta, Equitable Bldg. Chicago, 7-9 So. Jefferson St.

The Golden-Anderson Valve Specialty Co., of 107 Sixth St., Pittsburg, Pa., are issuing a catalog, which describes a line of valves with which all engineers should be familiar. The Anderson non-return valves protect the boiler with an absolute safety stop and they are made in the angle and globe type. A copy of this catalog, which also contains a description of high pressure steam traps or other specialties, will be sent free upon request.

NEW POWER PLANTS AND IMPROVEMENTS

The Detroit United Railway is building an addition to its power plant on Riopelle Street, Detroit, Mich. Estimated cost, $18,000.

The Portland Cement Co., of Portland, Me., have recently completed the erection of a new brick and concrete power house.

The municipal power house, at Athens, Ala., has recently been improved and an addition has been added, owing to the growth of the city.

The Monterey Gas and Electric Co., of Monterey, Cal., is making extensive improvements on its power plant.

The People's Railway Co., of Dayton, Ohio, is building a new one-story power house, 120 x 128 feet, which, upon completion, will furnish electric current for a modern street railway system.

The Central and Eastern Colorado Power Companies will shortly build a large dam and three power plants at Estes Park, near Denver, Col. Upon completion it is estimated that the cost will be $10,000,000, and that 30,000 horsepower will be generated.

The Northern Light and Power Co. will shortly begin operations on a new power house on Cow Creek, near Redding, Colo.

The Elkins Power Co., recently incorporated, will build an electric light and power plant at Elkins, W. Va., at a cost of $30,000.

The Sweat-Comings Co are building a new power house at Richford, Vt. Augustus Garrow, of Enosburg Falls, has received the contract.

The Calumet and Arizona Smelter Co., are building a new power house at Hancock, Mich.

The Southern Pacific Railroad have recently let a contract for a $900,000 power house at Fruitvale, Cal., to supply electric power for its trans-bay lines at San Francisco. These lines will be transformed from steam to electrically operated roads.

The Big Bend Water Power Co. will build a power plant on the Spokane River, 28 miles below Spokane, Wash. It is estimated that 22,250 horsepower can be generated.

A new electric power plant is being built by the Wenatchee Electric Company, at Wenatchee, Wash., as a relief plant to supply the extra power which the present plant is unable to furnish. It is the intention of the company to later construct a large water power plant.

The breaking of the piston rod and the sudden stoppage of a 100-horse power gasoline engine in the plant of the Saranac Lake Lighting Power Co., on August 16, caused a two-ton fly wheel to burst into a dozen pieces.

Salesman Wanted

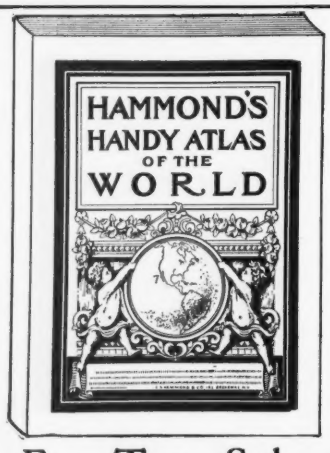
A number one Steam Trap Salesman for territory west of Harrisburg in Pennsylvania. A good man who can show results can make $50.00 a week. Moorehead Mfg. Co., 323 Fulton Bldg., Pittsburg, Pa.

Now Ready!

Our New Line
OF
25c. BOOKS
FOR ENGINEERS
Nearly 60 Titles

Send at once for full descriptive Circulars
FREE

Spon & Chamberlain
Publishers of Technical Books
123 P. E. Liberty St.,
NEW YORK



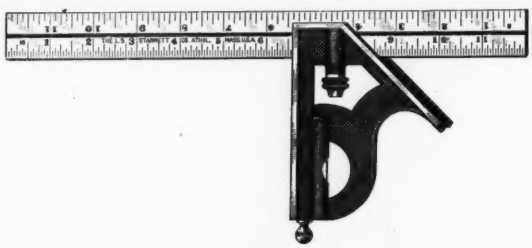
Free For Two Subscribers

A book of 104 pages, size 5¾ x 8 inches, containing 64 colored maps, including new maps of each State and Territory in the United States and every country in the world. These maps are new and up-to-date, and are well worth many times the price asked. It also gives the population of all the principal cities in the United States and of the world, and shows the flags of all nations in colors. There is also a special map of Western United States, showing forest reserves and Reclamation Projects, with a summary of the principal Reclamation Projects of the United States Reclamation Service, together with other information of exceptional value. If you have not a good geography or other up-to-date atlas, get one of these by all means.

Publishers' price, $1.00. Our price, 50 cents, or will be sent free, as a premium, for two subscribers to The Practical Engineer, at 50 cents each.

THE PRACTICAL ENGINEER,
46 North Twelfth Street, Philadelphia.

Free for Four Subscriptions



And all you have to do to get a six inch Starrett Combination Square just like the cut shown above is to send us **four** subscriptions to The Practical Engineer at fifty cents each. This is one of the most convenient and useful tools ever devised for mechanics use. It is a complete substitute for a whole set of try squares and can be put to a hundred different uses.

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